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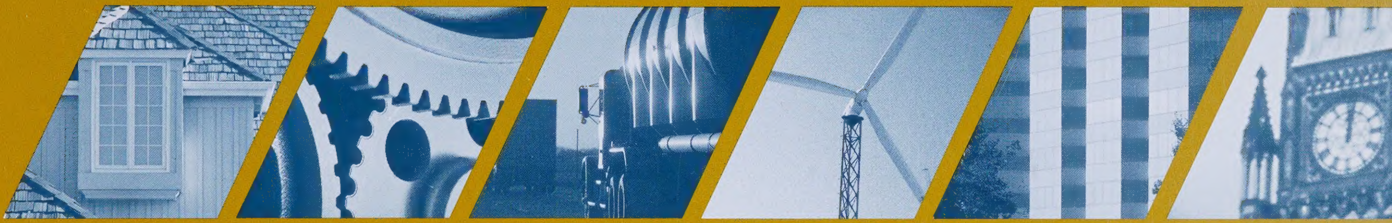
Improving Energy Performance in Canada

Report to Parliament Under the *Energy Efficiency Act*
For the Fiscal Year 2003–2004



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Published by the authority of the Minister of Natural Resources Canada
Government of Canada

Aussi disponible en français sous le titre :
Améliorer le rendement énergétique au Canada –
Rapport au Parlement en vertu de la *Loi sur l'efficacité énergétique*, Pour l'année financière 2003-2004

Cat. No. M141-10/2004E
ISBN 0-662-39608-1

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Her Excellency the Right Honourable Adrienne Clarkson,
C.C., C.M.M., C.D.
Governor General of Canada and Commander-in-Chief

Your Excellency,

I have the honour to present the *Report to Parliament Under the* Energy Efficiency Act for the fiscal year ending March 31, 2004, in accordance with Section 36 of the Act.

Respectfully submitted,

R. John Efford

The Honourable R. John Efford, P.C., M.P.
Minister of Natural Resources Canada

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Minister's Foreword

I am pleased to present the eleventh report to Parliament under the *Energy Efficiency Act*. It outlines the accomplishments in energy efficiency and the use of renewable energy that the Government of Canada has achieved through Natural Resources Canada (NRCan) in 2003–2004.

Working to improve energy efficiency remains a priority for the Government of Canada. Through its various programs, initiatives and regulations, NRCan has been helping governments, industry and individuals across Canada to increase energy efficiency and reduce consumption. Among our initiatives are a number of innovative research and development programs that have helped Canada become a world leader in clean and renewable energy technology.

Curbing the effects of climate change requires all of us to take action. That is why we have asked Canadians to take the One-Tonne Challenge and reduce their individual greenhouse gas emissions by 20 percent. Using less energy and using it wisely is something we all can do to reduce the effects of climate change.

NRCan will continue to support the responsible use of our energy resources. The EnerGuide for Houses Retrofit Incentive program is an example of this commitment. By encouraging Canadians to make efficiency improvements, decrease their own energy bills and reduce environmental impacts, this program is raising the level of energy efficiency in the housing sector.

The Government of Canada's approach to climate change is focused on making the right choices for Canada. By promoting energy efficiency and the use of renewable energy, NRCan is ensuring that the actions taken contribute to the long-term goals of building a sustainable economy for the 21st century, a healthier environment and strong communities, while affirming Canada's place in the world.

R. John Efford

The Honourable R. John Efford, P.C., M.P.
Minister of Natural Resources Canada

Executive Summary

With the ratification of the Kyoto Protocol in 2002, Canada formally committed to a specific target for reducing its greenhouse gas (GHG) emissions to address the global issue of climate change. Canada's industrialized economy makes decreasing GHG emissions a particular challenge.

Canadians spend almost $114 billion per year on energy to heat and cool their homes and offices and to operate their appliances, cars and industrial processes. Several factors contribute to Canadian energy demand: a vast geography, a northern climate with extreme seasonal variations in temperature and an economy founded on an abundance of natural resources.

Types of Energy Use

There are two general types of energy use: primary and secondary. Primary use comprises Canada's total consumption, including energy required to transform one form to another – such as coal to electricity – and to deliver energy to consumers. Secondary use comprises energy consumed for residential, agricultural, commercial/institutional, industrial and transportation purposes.

Key highlights in energy use include the following:

- Between 1990 and 2002, the latest year for which figures are available, primary energy use increased by 21.5 percent.
- In 2002, secondary use accounted for 69.1 percent of primary energy use and produced 66.2 percent (482 megatonnes) of Canada's total GHG emissions. This last figure includes emissions produced by utilities in meeting the demand for electricity.
- Without improvements in energy efficiency made to buildings and equipment and the changes in the behaviour of energy users during the past several decades, the increases in energy use would have been much higher.

The industrial sector consumes the most energy, accounting for 38.7 percent of total secondary energy use in 2002. Transportation is second (28.1 percent), followed by residential (17.0 percent), commercial/institutional (13.8 percent) and agriculture (2.5 percent).

Five key factors contribute to changes in energy use:

- Activity – variations in levels of activity within sectors
- Weather – annual fluctuations
- Structure – shifts toward more or less energy-intensive activities
- Service level – increased penetration of auxiliary equipment and space cooling in commercial/institutional buildings
- Energy efficiency – how effectively energy is being used

Promoting Energy Efficiency

For the past decade, Natural Resources Canada (NRCan) has promoted energy efficiency and the use of alternative energy as a means to reduce GHG emissions and save money. NRCan exercises a broad range of policy instruments, including leadership, information, voluntary actions, financial incentives, research and development (R&D) and regulation. Regulation allows for the enforcement of compliance.

The *Energy Efficiency Act*, which came into force in 1992, provides for the making and enforcement of regulations concerning minimum energy performance levels for energy-using products, as well as the labelling of energy-using products and the collection of data on energy use. The *Energy Efficiency Regulations* are described in Chapters 4, 5 and 6, with an emphasis on their contribution to energy efficiency in the housing, building and industrial sectors, respectively.

Energy Intensity / Energy Efficiency

As explained in Chapter 2, although aggregate energy intensity is sometimes used as a proxy for energy efficiency, there is a difference between the two terms. Understanding this difference is important when comparing Canada with other countries. Energy intensity is a broader measure, capturing not only energy efficiency, but also the impacts of weather variations and changes in the structure of the economy (among other things). While Canada has a higher aggregated intensity than most International Energy Agency (IEA) countries, it has made significant overall improvements in energy efficiency. According to a recent IEA report[1] that examined 13 countries, Canada has the fourth fastest rate of energy efficiency improvement.

Evidence of Change

As explained in this report, recent growth in energy use is primarily due to increased activity in various sectors; however, this growth would have been far greater without improvements in energy efficiency. As reported in Chapter 2, energy efficiency improvements made between 1990 and 2002 are estimated to have reduced GHG emissions by almost 50 megatonnes and decreased energy expenditures by $11.6 billion in 2002.

Over this period, the residential sector recorded a 19.8 percent increase in energy efficiency. The figures for industry (14.2 percent), transportation (9.9 percent) and the commercial/institutional (7.3 percent) sectors demonstrate that improvements in energy efficiency are being made throughout the economy.

Through improvements in energy efficiency, Canadians can reduce the size of their energy bills and achieve important environmental goals. In the short term, changes to less GHG-intensive fuels (e.g. from coal to natural gas) can help reduce GHG emissions. However, over the long term, reducing GHG emissions to 1990 levels will require more widespread use of alternative energy.

In recent years, the production of energy derived from alternative sources has increased significantly. Between 1990 and 2001, the last year for which data are available, the amount of electricity generated from the sun, wind and biomass increased by 204 percent.

Measuring Progress

The goal of NRCan's efficiency and alternative energy (EAE) initiatives is to improve energy use by altering energy-consumption practices and patterns in Canada. Measuring the effectiveness of the initiatives is of paramount importance to the success and viability of EAE.

NRCan regularly measures three aspects of EAE programs. **Program outputs** are items produced on a regular basis, such as marketing and informational materials, demonstration projects, financial incentives and regulations. These items are designed to deliver **program outcomes**, such as changes in behaviour. These alterations lead to **market outcomes**, such as observable differences in the amount and type of energy consumed.

Engaging Canadians

To maximize the effectiveness of its initiatives, NRCan engages a growing number of partners from the private and public sectors. Dozens of cooperative agreements are in place with a broad range of businesses, community groups and other levels of government.

These initiatives engage Canadian society, along with every sector of the economy, in new and more efficient approaches to secondary energy use and in the development and deployment of renewable energy sources.

This report provides an overview of the work being done in each sector, highlights NRCan's EAE programs and lists their key achievements for 2003–2004. All programs are described in the corresponding sector chapter. Program entries for market transformation programs also include quantitative performance indicators in graph or table format. A list of NRCan's EAE initiatives and expenditures appears in Appendix 1.

[1] *Oil Crises and Climate Challenges – 30 Years of Energy Use in IEA Countries*, Paris, IEA, 2004.

Housing

The residential sector accounts for 17 percent of total secondary energy use and 15.6 percent of Canada's annual GHG emissions. Between 1990 and 2002, residential energy use increased by 8.6 percent, while GHG emissions increased by 8.4 percent. The growth in energy use was largely due to increased activity.

Improvements in energy efficiency, through superior construction of new homes and reduced energy use by occupants, moderated that increase. Without these improvements, which were supported by NRCan programs, total residential energy consumption would have been 19.8 percent higher.

NRCan programs in the housing sector focus on three areas: new houses, existing houses and residential equipment. The majority of dwellings in Canada are detached and semi-detached houses, so most NRCan programs in this sector focus on these types of homes.

New Houses

Houses built in Canada today are more energy efficient than ever. For example, air-leakage rates have improved dramatically. Data recorded during audits performed under EnerGuide for Houses demonstrate that, prior to retrofits, the average number of air changes per hour for homes built before 1945 was 12; the number for homes built between 2000 and 2004 is 8.

NRCan's R-2000[2] Standard encourages Canadian builders to build, and Canadian consumers to purchase, houses that are more energy efficient and environmentally responsible than is required by current Canadian building codes. A house built to the R-2000 Standard undergoes only 1.1 air changes per hour and consumes 64 percent less energy than the average house constructed in 1970. EnerGuide for (New) Houses is an energy-performance rating and labelling scheme based on the R-2000 Standard, but targets large-volume, mass-market builders.

NRCan's Super E™ House Program[3] supports the export of energy-efficient and environmentally friendly housing technology to foreign builders. Thanks to this program, the R-2000 concept has been adapted to several international markets. Since the program began in 1998, 91 units have been built in Japan and 92 units in the United Kingdom. In both Japan and the U.K., Super E™ is now established as high quality housing uniquely available from Canada and its exporters.

Existing Houses

NRCan programs for existing houses encourage Canadians to improve the energy efficiency of their homes, particularly when undertaking renovation and maintenance projects. In October 2003, a retrofit incentive was launched whereby homeowners can qualify for a non-taxable grant when retrofitting their homes. Homeowners who completed retrofit activities experienced an average annual energy savings of 19 percent.

In 2003–2004, more than 48 000 houses underwent energy evaluations. Retrofitted homes saw a reduction in energy consumption of between 20 and 38 percent; grant recipients reduced their carbon dioxide emissions by an average of 4 tonnes per year, per house.

Residential Equipment

NRCan develops regulations and sets standards for the energy performance of residential equipment, such as appliances and furnaces. Through labelling and promotional activities, NRCan also encourages the manufacture and purchase of more energy-efficient equipment. Residential equipment programs consist of EnerGuide for Equipment and the international ENERGY STAR® label.

From 1990 to 2000, the EnerGuide labelling program is estimated to have resulted in a total energy savings of 531 gigawatt hours and a reduction of 287 kilotonnes of GHG emissions. From 2003–2004, over 140 organizations have been recruited to participate in and promote ENERGY STAR® in Canada.

[2] R-2000 is an official mark of Natural Resources Canada.
[3] Super E is an official mark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

Buildings

Retail and office space account for more than half of the commercial/institutional sector's energy demands. Between 1990 and 2002, commercial/institutional energy use (excluding street lighting) increased by 30.8 percent. In 2000, the commercial/institutional sector accounted for 13.8 percent of total secondary energy use and 13.4 percent of GHG emissions. However, improvements in energy efficiency worked to decrease total energy use by 7.3 percent.

NRCan programs address all building types with measures that target new buildings, existing buildings and equipment.

New Buildings

NRCan provides financial incentives to builders and developers who incorporate energy-efficient features into new construction projects. Since its inception, the Commercial Building Incentive Program has issued incentives to 372 projects, thereby avoiding 78 kilotonnes of GHG emissions.

NRCan also provides assistance to builders and developers of industrial structures. In 2003–2004, six contribution agreements were signed; moreover, 17 architects and engineers received training on energy-efficient industrial building design.

Existing Buildings

NRCan provides commercial organizations and public institutions with access to tools and financial assistance to improve the energy efficiency of their existing buildings. Between 1998 and 2004, federal contributions to renovation and retrofitting projects totalled $30.5 million, and client investment equalled $571.4 million. Energy savings achieved through these projects was worth $80 million.

Equipment

Through a range of equipment programs, NRCan establishes standards and regulations for energy efficiency and supports the development, testing, deployment and promotion of new technologies.

In 2003–2004, NRCan established minimum performance standards for water chillers and exit signs; the cumulative annual reductions attributable to these standards are estimated to be approximately 0.02 megatonnes in the year 2005 and 0.17 megatonnes in the year 2020. NRCan also provides comparative information on the energy performance of equipment and uses the international ENERGY STAR® label to identify the most energy-efficient products available.

Through its Refrigeration Action Program for Buildings, NRCan supports the development and adoption of refrigeration technologies that reduce energy consumption, synthetic refrigerant use and GHG emissions. In 2003–2004, the program launched a demonstration project of integrated heating, ventilation and air conditioning (HVAC) and refrigeration technologies in a Quebec supermarket, as well as in three ice rinks.

NRCan also helps to develop and promote the adoption of intelligent building technologies and practices that reduce energy consumption and GHG emissions. Furthermore, NRCan distributes and supports building simulation software for the Canadian housing and building industry. To date, the software has simulated improved energy efficiency for over 128 000 houses and 380 commercial buildings.

Community Energy Systems

NRCan works in partnership with Canadian communities and businesses to develop Sustainable Community Energy Plans, using tools that will help reduce energy demand, emphasize conservation and promote reliance on local renewable energy sources. In 2003–2004, NRCan developed a planning methodology that enables municipalities to develop a long-term growth strategy while minimizing energy consumption and maximizing renewable energy use.

Industry

The industrial sector includes all manufacturing industries, all mining activities, forestry and construction, but excludes electricity generation. Overall, industrial energy demand accounts for 38.7 percent of secondary energy use and 33.8 percent of GHG emissions.

Between 1990 and 2002, industrial energy use increased by 16.9 percent, while industrial GHG emissions grew by 15.2 percent.

Improvements in energy efficiency helped reduce total energy use by 14.2 percent. Within this sector, NRCan's energy efficiency initiatives focus on industrial processes and technologies, equipment and buildings.

Industrial Processes and Technologies

NRCan works with companies and associations to address barriers to planning, implementing, tracking and reporting energy efficiency improvement targets in industry. Between 1990 and 2002, the Canadian Industry Program for Energy Conservation achieved an average energy intensity improvement of 1.9 percent per year, thereby avoiding 23.8 megatonnes of GHG emissions.

NRCan also designs, develops and deploys technologies for cleaner fossil fuel power generation. In 2003–2004, NRCan devised a new combustion protocol for assessing energy and emission performance of bitumen/water emulsions for industrial applications.

NRCan supports Canadian industry in the development and adoption of innovative energy-efficient practices, such as Process Integration (PI) and advanced process control systems. In 2003–2004, NRCan completed a successful PI collaboration that identified energy savings of $4.5 million per year and GHG reductions of 34 kilotonnes per year.

In 2003–2004, NRCan helped finance a company that is developing a new mechanical transmission for diesel generator sets. NRCan also is supporting the development of a production-scale process that recycles post-industrial polyethylene cross-linked foam waste material into foam sheet products.

The *Government of Canada Action Plan 2000 on Climate Change* has allocated $10 million to the Minerals and Metals Program, which has its home in the Minerals and Metals Sector of NRCan.

Equipment

Through regulation, standards setting, labelling and research support, NRCan programs work to improve the energy efficiency of equipment used in industry.

Canada's *Energy Efficiency Regulations* set out minimum performance standards through the *Energy Efficiency Act* to eliminate the less energy-efficient models of energy-using equipment from the market. EnerGuide for Equipment promotes and encourages the manufacture, purchase and use of more energy-efficient industrial equipment. In 2003–2004, market studies were completed for compressors, uninterruptible power supplies, battery chargers, arc welders and pumps.

Transportation

The transportation sector accounts for 28.1 percent of secondary energy use and 34.2 percent of GHG emissions. This sector is divided into three sub-sectors: passenger, which comprised 56.7 percent of the sector's total energy use in 2002; freight, 39.3 percent; and off-road, 4.0 percent.

Between 1990 and 2002, transportation energy use grew by 22.8 percent. Two main factors were responsible for the rise: an increase in activity and shifts between modes of transport. In the light-duty vehicle mode, although the fuel efficiency of new vehicles has improved markedly, average fuel economy has not changed significantly, because new cars and trucks are increasingly heavier and feature more powerful engines.

Between 1990 and 2002, improvements in energy efficiency reduced energy use in this sector by 9.9 percent from what it would have been in the absence of such improvements.

In 2002, road transport, at 78.1 percent, was the largest user of energy in the sector. Passenger energy use accounted for 60.5 percent of that total, and freight, 39.5 percent. In this sector, NRCan focuses its energy-use programs on road transport, dividing them into four areas: vehicles, R&D, alternative transportation fuels and longer-term transportation technology.

Vehicles

NRCan intends to bring about a 25 percent improvement in the fuel efficiency of new light-duty vehicles sold in Canada by 2010. GHG reductions of 5.2 megatonnes by 2010 are being sought.

NRCan programs encourage manufacturers to meet targets for fuel consumption and to improve fuel efficiency by adopting advances in technology. Parallel programs encourage motorists to purchase energy-efficient vehicles. Under a voluntary agreement, manufacturers attach EnerGuide fuel-consumption labels to vehicles to help purchasers make informed buying decisions.

In 2003–2004, Idle-Free Awareness campaigns were completed in many cities across Canada and a Tire Inflation campaign was developed and launched.

In partnership with fleets, industry stakeholders and other levels of government, NRCan delivers information materials, workshops, demonstrations and training to fleet operators to help improve fuel efficiency and encourage the use of alternative fuels such as natural gas in commercial and municipal fleets.

During 2003–2004, the SmartDriver workshops trained more than 160 000 novice and experienced drivers in fuel-efficient driving techniques and introduced over 700 new instructors to the Fleet Vehicles Initiative.

Transportation Research and Development

NRCan supports research into transportation technologies that improve the energy efficiency of vehicles and reduce GHG emissions.

During 2003–2004, recent developments in hydroforming have enabled significant productivity gains and weight reductions for complex structural components in the automotive industry.

In the mining industry, NRCan plays a lead role in a consortium that is developing a mining vehicle powered by fuel cells. The fuel cell locomotive is now undergoing long-term reliability testing of the fuel cell power plant.

Alternative Transportation Fuels

NRCan promotes the use and development of alternative fuels, such as ethanol and biodiesel, to minimize environmental impacts.

NRCan's Future Fuels Initiative, co-managed with Agriculture and Agri-Food Canada, aims to increase the supply and use of fuel ethanol produced from biomass. In 2003–2004, the initiative completed an ethanol-blended gasoline awareness campaign in partnership with Ontario and Quebec fuel retailers.

During 2003–2004, as part of its Ethanol Expansion Program, NRCan allocated contributions to seven projects from across Canada that plan to increase domestic ethanol production by a total of 750 million litres per year.

NRCan's Biodiesel Initiative supports the Government of Canada's proposed target of 500 million litres of biodiesel production per year by 2010.

Transportation Technologies

NRCan, in partnership with industry, develops and evaluates hydrogen and fuel cell technologies to reduce GHG emissions and minimize other environmental impacts.

In 2003–2004, the Canadian Transportation Fuel Cell Alliance, a public-private initiative, produced a draft hydrogen installation code for Canada and participated in ongoing codes and standards activities at a national and international level.

In partnership with industry, NRCan is working to develop and deploy leading-edge hydrogen and transportation technologies that will reduce GHG emissions.

Renewable Energy

Most of the renewable energy used in Canada comes from either hydro-electricity or thermal energy from biomass. In 2002, renewable energy generation capacity from renewable sources accounted for 61 percent of total Canadian electricity capacity.

In 2003, hydro power accounted for approximately 60 percent of total electricity generation; small-scale hydro-electric projects constitute about 4 percent of Canada's electricity-generating capacity and offer potential for increased production. Several other renewable energy sources and technologies exist in Canada: bioenergy, earth energy, wind energy and solar energy.

Bioenergy, a renewable source of energy derived from biomass, contributes about 6 percent of Canada's primary energy and represents Canada's second largest renewable energy source. Earth energy, produced by ground-source heat pumps, supplies less than 1 percent of the market for space and water heating and cooling in Canada.

In 2003, wind energy accounted for less than 1 percent of Canada's total electricity generation; however, the potential is much greater. An NRCan study estimated that wind energy potentially could supply 11 percent of total Canadian electricity consumption.

Three main technologies use solar energy: passive solar technologies, active solar thermal systems and solar electric (photovoltaic) systems. The Canadian Coast Guard is the largest individual user of photovoltaic

systems in Canada, with an estimated 7000 navigational buoys, beacons and lighthouses.

NRCan delivers several initiatives to increase the use of small-scale renewable energy in Canada. These initiatives support education and promotion programs, develop standards and research, and provide financial incentives for capacity building.

Renewable Energy Programs

Between 1998 and 2001, NRCan entered into pilot projects to purchase electricity from emerging renewable energy sources (ERES). NRCan has pledged to purchase 20 percent of its electricity from ERES by 2010.

Through the Photovoltaic and Hybrid Systems Program, NRCan initiated a partnership to develop and demonstrate a multi-energy (hybrid) technology that will combine and integrate several types of renewable energy into a single system with a generator.

More than $2.5 million in federal incentives was distributed to 89 projects under the Renewable Energy Deployment Initiative, valued at $22 million.

In 2003–2004, the Renewable Energy Technologies Program funded work toward the development of "new and improved engineering designs of equipment for small hydro power plants to increase efficiency and reduce costs.

NRCan's Wind Power Production Incentive (WPPI) aims to support the installation of 1000 megawatts of new wind energy capacity by 2007. By displacing other sources, wind power capacity installed under the WPPI is projected to reduce annual GHG emissions by 3 megatonnes by 2010. In 2003–2004, guidelines were developed to assist wind developers, utilities and businesses in preparing an Environmental Impact Statement under the *Canadian Environmental Assessment Act*.

The Market Incentive Program is a $25-million program to stimulate emerging markets for renewable electricity. The Government of Canada will provide a short-term financial incentive of up to 40 percent of the eligible costs of an approved project. In 2003–2004, three contribution agreements were signed with the provincial governments of New Brunswick, Ontario and Prince Edward Island.

Federal House in Order

As the country's largest single enterprise, the Government of Canada is getting its own energy-use house in order. The Government of Canada has established a target of a 31 percent reduction in its GHG emissions by 2010.

The Government of Canada has already achieved a 24 percent reduction since 1990 through a series of measures, including building retrofits, improvements in fleet management, downsizing of operations and purchases of "green" power. In 1990, emissions were 3925 kilotonnes; in 2002, emissions were down to 2971 kilotonnes; the 2010 target is 2724 kilotonnes.

The departments and agencies responsible for 95 percent of federal GHG emissions have been assigned specific targets under a three-year action plan and must report annually on their programs. NRCan provides services and support to federal departments and agencies to help them achieve their energy efficiency targets.

The Federal House in Order initiative includes such activities as GHG inventory and tracking, purchases of "green" power and efforts to reduce outside emissions.

Federal Initiatives

Under the Federal Buildings Initiative (FBI), NRCan, through public-private partnerships, helps federal government organizations implement energy efficiency improvements in order to reduce energy use, GHG emissions and operating costs.

During 2003–2004, $25.6 million was invested by the private sector in FBI projects. FBI projects had an average energy intensity improvement of 20 percent by project.

The Federal Industrial Boiler Program (FIBP) provides technical and project-management services to federal departments and agencies that are implementing energy efficiency projects. Since its inception in 1991, the FIBP has worked with many federal government departments to reduce energy costs. These partnerships have reduced GHG emissions by an average of 4.7 kilotonnes per year.

Through the Federal Vehicles Initiative, NRCan assists other federal departments and agencies in improving the efficiency of their fleets and switching to cleaner burning fuels. During 2003–2004, the Government of Canada acquired 293 alternative fuel vehicles. Additionally, three new alternative fuel sites were established and two additional sites are under construction.

General Programs

Outreach

The Office of Energy Efficiency's Outreach program provides information and activities to increase Canadians' awareness and understanding of climate change and the link to energy use, and to encourage Canadians to take action. The program also targets youth as future energy consumers.

In 2003–2004, there was a 30 percent increase in the volume of publications distributed and a 300 percent increase in Web site visits, indicative of increasing interest in energy efficiency.

The One-Tonne Challenge was launched in March 2004. The One-Tonne Challenge asks Canadians to reduce their personal annual GHG emissions by one tonne by using less energy, reducing waste and conserving water and other resources.

Program of Energy Research and Development

NRCan funds R&D designed to ensure a sustainable energy future for Canada in the best interests of our economy and our environment. In 2003–2004, NRCan allocated $41.5 million to energy R&D programs managed and performed in the department.

Climate Change Technology Development and Innovation Program

NRCan aims to accelerate the development of cost-effective R&D mitigation technologies in multiple sectors. In 2003–2004, 15 new R&D projects were near completion.

International Initiative for Technology Development

In 2003–2004, NRCan launched the Clean Energy Technology Portal and provided marketing support at five national and international conferences.

Climate Change Technology and Innovation Research and Development

In 2003–2004, NRCan allocated $5.1 million to energy R&D programs managed and performed in the department.

Introduction

Greenhouse Gases and Climate Change

Climate change is a global challenge arising from the continuing buildup in levels of anthropogenic (human-produced) greenhouse gases (GHGs) in the atmosphere, in addition to naturally occurring emissions. GHGs are composed of a number of gases, and the main source of anthropogenic emissions is the combustion of fossil fuels. In December 1997, Canada and more than 160 other countries met in Kyoto, Japan, and agreed to targets to reduce GHG emissions. Canada's target is to reduce its GHG emissions to 6 percent below 1990 levels by the first commitment period (2008 to 2012). The Government of Canada ratified the Kyoto Protocol and notified the United Nations of its decision on December 17, 2002.

Natural Resources Canada's Efficiency and Alternative Energy Program

Since the early 1990s, Natural Resources Canada (NRCan) has emphasized the promotion of energy efficiency and the use of alternative energy (i.e. alternative transportation fuels and renewable energy) as a means to reduce GHG emissions, particularly in relation to the Kyoto Protocol. A complete list of NRCan's efficiency and alternative energy (EAE) initiatives in 2003–2004 is provided in Appendix 1. These initiatives engage Canadian society and all major sectors of the economy in new and more advanced approaches to secondary energy use – i.e. to the consumption of energy in the residential, commercial/institutional, industrial and transportation sectors.

NRCan's EAE initiatives are managed by

- the Office of Energy Efficiency, which delivers market transformation initiatives to improve energy efficiency and the use of alternative transportation fuels
- the CANMET[1] Energy Technology Centre and the Mineral Technology Branch, which deliver EAE research and development (R&D) initiatives
- the Electricity Resources Branch, which delivers market transformation initiatives for renewable energy
- the Science Branch of the Canadian Forest Service, which undertakes R&D in the use of forest biomass for energy

In its efforts to reduce GHG emissions, NRCan emphasizes partnership and cooperation with stakeholders, such as other levels of government, the private sector and non-governmental organizations. Using this approach, the demand side of the energy market moves toward more energy-efficient capital stock, production processes and operating practices without reducing service or comfort levels. On the supply side, Canada participates in developing technology for tapping renewable energy resources and alternative transportation fuels as well as for increasing the energy efficiency of production.

[1] CANMET is the Canada Centre for Mineral and Energy Technology.

In This Report

This eleventh annual Report to Parliament focuses principally on EAE initiatives that address secondary energy use. Chapter 1 provides the policy context and strategic overview. Trends in energy use and GHG emissions in Canada are discussed in Chapter 2. Chapter 3 summarizes work undertaken during the reporting period to improve the quality and coverage of performance indicators for the initiatives described in Chapters 4 through 9. Chapters 4 to 7 review individual EAE initiatives to improve energy use in housing, buildings, industry and transportation, highlighting their achievements and progress indicators. Chapter 8 deals with renewable energy sources and use. Chapter 9 describes the Government of Canada's actions to improve its own use of energy. Chapter 10 describes general programs not specific to EAE initiatives discussed in Chapters 4 to 9. The final chapter describes intergovernmental cooperation in EAE. Appendix 1 contains information on NRCan's EAE expenditures. Appendix 2 contains detailed information on the data presented in this report.

Chapter 1: Policy Context and Legislation

Federal Policy and Measures on Energy Efficiency and Alternative Energy

Energy use has been a policy concern since the 1970s when governments responded to the oil crises of 1973 and 1979 by promoting energy conservation and renewable energy sources. Toward the end of the 1980s, individuals, organizations and governments around the world became concerned that greenhouse gas (GHG) emissions produced by burning fossil fuels – such as coal, oil and natural gas – could contribute to climate change. In 1990, Canada's concern about its GHG emissions (which result mostly from energy use) created a new objective for a revitalized set of federal measures to encourage investment in corporate and consumer efficiency and alternative energy (EAE) opportunities.

The federal budget of February 1997 provided $60 million over three years for new initiatives to improve energy efficiency in new commercial buildings; encourage commercial building retrofits; provide for energy performance assessments of houses; and stimulate demand for cost-effective, commercially available renewable energy systems for space and water heating and cooling. This funding was renewed in the February 2000 federal budget and further extended to March 2006 in the budget of February 2003.

In 1992, Canada signed and ratified the *United Nations Framework Convention on Climate Change* (UNFCCC). In December 1997, at the third Conference of the Parties to the UNFCCC in Kyoto, Japan, the participating countries agreed to reduce GHG emissions from 1990 levels within 2008 to 2012. Canada pledged to reduce its emissions by 6 percent. The Government of Canada ratified the Kyoto Protocol and notified the United Nations of its decision on December 17, 2002. With Russia's ratification on October 25, 2004, the Protocol entered into force on February 16, 2005.

In February 1998, the federal budget provided $150 million over three years for a Climate Change Action Fund to help Canada develop its response to the Kyoto Protocol. This funding was renewed for another three years in the February 2000 federal budget. The fund has five components:

- **Building for the Future** – to sustain domestic efforts to address climate change and to enable Canada to meet GHG-reporting obligations
- **International Policy and Related Activities** – to enable Canada to enhance its international analysis and negotiating capacity
- **Public Education and Outreach** – to build public awareness and understanding
- **Technology Early Action Measures (TEAM)** – to demonstrate cost-effective technologies
- **Science, Impacts and Adaptation** – to advance the knowledge of the magnitude, rate and regional distribution of the impacts of climate change on Canada and to support the development of adaptation strategies

The federal, provincial and territorial governments established the National Climate Change Process in 1998 to examine the impact, costs and benefits of the Kyoto Protocol and the implementation options open to Canada. From spring 1998 to winter 1999–2000, the process engaged more than 450 experts from across Canada, and their recommendations were provided to governments in fall 2000. In October 2000, the Government of Canada announced its *Action Plan 2000 on Climate Change*, representing its contribution to *Canada's First National Climate Change Business Plan* developed with the provinces and territories. Funding of $500 million over five years was provided in the budget update of October 2000 for a broad range of measures that commenced operation in 2001–2002.

In November 2002, the Government of Canada released the *Climate Change Plan for Canada*, outlining a three-step approach: the first being the measures implemented under *Action Plan 2000 on Climate Change*; the second, a set of new initiatives; and the third, options for attaining the target by the end of the first commitment period in 2012. The federal budget of February 2003 provided new funding of $2 billion over five years commencing with fiscal year 2003–2004 for a wide range of climate change initiatives identified in the Plan. On August 12, 2003, the details of the investment of $1 billion of this amount were announced. Many of these measures were implemented under the authority of the *Energy Efficiency Act* and are included in this report.

Responsibility

The following organizations within Natural Resources Canada (NRCan) are responsible for the initiatives described in this report.

The Office of Energy Efficiency (OEE) was established in April 1998 with a mandate to strengthen and expand Canada's commitment to energy efficiency, in particular to help address the challenges of climate change. The OEE's initiatives target all final energy consumers and emphasize partnerships and economic investment. Its program objectives are to overcome the market barriers posed by inadequate information and knowledge about energy efficiency and alternative transportation fuels, and to address institutional deterrents in energy-use markets and economic constraints that energy users face. The OEE is also responsible for identifying opportunities for new and heightened energy efficiency measures. The National Advisory Council on Energy Efficiency assists the OEE by providing advice and guidance. The council comprises energy efficiency experts and leaders from all sectors of the economy.

NRCan's Office of Energy Research and Development (OERD) strategically plans, manages and funds non-nuclear energy R&D for the Government of Canada that supports Canada's energy priorities. Through the interdepartmental Program of Energy Research and Development (PERD), the OERD provides more than 50 percent of its annual $57-million budget to study options related to energy efficiency and alternative energy. PERD also focuses on finding technology solutions to help Canada address its climate change challenges.

OERD also manages the Technology and Innovation Research and Development (T&I R&D) initiative, part of the *Climate Change Plan for Canada* announced in 2003. T&I R&D programs will play an important role over the next five years in accelerating the expansion of knowledge and the development of technologies to help achieve GHG greenhouse gas reductions in the longer term. Energy efficiency will be a key element. As well, the OERD coordinates the Government of Canada's participation in international energy R&D. Canada's objectives are mainly advanced through the International Energy Agency working parties, implementing agreements and the Committee for Energy Research and Technology, chaired by NRCan. NRCan also fosters collaborative energy R&D with the United States and Mexico.

The CANMET Energy Technology Centre (CETC) focuses on technology development and deployment. Technology development activities are performed on a cost-shared basis either through in-house R&D work at its laboratories or by providing funding support to its technology partners. CETC–Ottawa, in Ontario, works in partnership with a range of stakeholders to develop and disseminate innovative, cleaner energy technologies. These include energy-efficient technologies for homes, businesses and industry; renewable energy; alternative transportation fuels; district heating and cooling systems; advanced low-emissions combustion technologies; and energy-efficient metallurgical fuel products and technologies. CETC–Varennes, in Quebec, develops technologies that use energy wisely and help Canadians stay competitive in the marketplace. These include advanced drying technologies, heat transfer and storage systems, photovoltaics, renewable energy for remote communities and related software tools, such as RETScreen® International.

The Electricity Resources Branch's Renewable and Electrical Energy Division promotes the development of a sustainable renewable energy industry in Canada. It promotes investments in renewable energy systems for heating and cooling and provides information on renewable energy technologies. By strengthening markets for the renewable energy industry, its programs contribute to GHG reductions, job creation and export sales.

Outside of the Energy Technology and Programs Sector and the Energy Policy Sector, two other sectors within NRCan report on programs related to energy efficiency and alternative energy in this document. They are the Canadian Forest Service and the Minerals and Metals Sector.

The Canadian Forest Service of NRCan, in collaboration with partners from other governments, industry and universities, undertakes research in the areas of forest and biomass inventory and in the selection and testing of fast-growing forest crops. These activities address sustainability issues of R&D in the forest sector, rural and aboriginal forestry, and the protection of Canadian markets for forest products.

The Minerals and Metals Sector (MMS) of NRCan advances policies, science, regulations and knowledge that increase the contribution of the minerals and metals industries to Canada. MMS is committed to assisting Canada in reducing GHG emissions under the Kyoto Protocol. Initiatives now in place working towards that end are

- the *Government of Canada Action Plan 2000 on Climate Change* Minerals and Metals Program is working to reduce Canada's GHG emissions by enhancing mineral and metal recycling practices and assessing alternate production processes in industrial areas with high GHG-emitting activities
- ventilation on demand for underground mines that matches ventilation flow with production needs
- hydrogen-fuel-cell-powered vehicles for the underground mine environment
- the Canadian Lightweight Materials Research Initiative that develops low-density, high-strength, lightweight materials for more fuel-efficient ground transportation vehicles

Energy Efficiency Strategy

Most of NRCan's EAE initiatives deal solely with energy efficiency. Their goal is to improve energy efficiency by

- increasing the energy efficiency of new and existing buildings, equipment, systems and vehicles
- persuading individuals and organizations to purchase buildings, equipment, systems and vehicles that are more energy efficient
- influencing the energy-use practices of individuals and organizations
- developing technologies to give consumers, industry and communities new opportunities to improve energy efficiency

These measures help the demand side of the energy market move toward more energy-efficient capital stock, production processes and operating practices without reducing service or comfort levels.

Alternative Energy Strategy

Alternative energy includes renewable sources other than large hydro-electric facilities, new applications of conventional sources and new fuels, such as hydrogen for fuel cells. (Large hydro is not considered an alternative energy source because it is already a successful, well-established mode of energy production, supplying more than 60 percent of the electricity in Canada.) Some technologies, such as those related to the use of propane as a vehicle fuel and to forestry biomass, are already commercially available and accepted. Some have found applications in specialized markets, such as remote communities. Others are still in the early stages of development.

NRCan supports R&D to reduce costs, improve performance, develop safety and performance standards and increase the scope of renewable energy technologies. The department also provides incentives for investments in renewable energy systems and purchases of electricity generated from renewable sources, disseminates information to consumers, and assesses economic and environmental aspects of renewable sources of energy.

Federal initiatives are helping to expand the infrastructure (e.g. fuelling stations) for the sale of alternative transportation fuels, especially in urban areas where the provision of infrastructure is more economic. R&D focuses on ways to improve options in the use of these fuels.

Policy Instruments

NRCan's key policy instruments are as follows:

- leadership
- information
- voluntary initiatives
- financial incentives
- research and development
- regulation

Leadership

Leadership means setting an example for other levels of government and for the private sector by increasing energy efficiency and the use of alternative energy in the Government of Canada's operations.

Information

NRCan disseminates information to consumers, using methods that range from broad distribution to individual consultations with clients, to increase awareness of the environmental impact of energy use and to encourage consumers to become more energy efficient and to make greater use of alternative energy sources. Activities include publications, exhibits, advertising, toll-free lines, conferences, Web sites, workshops, training, building-design software and promotional products.

Voluntary Initiatives

Companies and institutions work with NRCan on a voluntary basis to establish and achieve energy efficiency objectives. NRCan's voluntary EAE initiatives target large consumers of energy in the commercial/institutional and industrial sectors and organizations whose products are important determinants of energy use. The initiatives involve industry-government agreements and, for groups of large industrial energy users, energy efficiency target setting. NRCan provides a variety of support services to assist and stimulate action by companies and institutions on energy efficiency, including developing standards and training.

Financial Incentives

NRCan uses financial incentives to encourage final users of energy to employ energy efficiency and renewable energy technologies and practices when they acquire, design or build new buildings or retrofit existing ones. NRCan also offers financial incentives for wind energy and for natural gas vehicles and refuelling infrastructure.

Research and Development

NRCan's EAE initiatives support the development and dissemination of more energy-efficient equipment, processes and technologies and alternative energy technologies. R&D also provides the scientific knowledge needed to develop the technologies, codes, standards and regulations required for the sustainable use of energy.

NRCan provides national leadership in energy science and technology (S&T) by undertaking in-house research in its own laboratories, by contracting out research activities to other organizations and through the federal PERD. PERD and TEAM are the only federal interdepartmental S&T investment funds that focus on the energy sector and its economic and environmental effects.

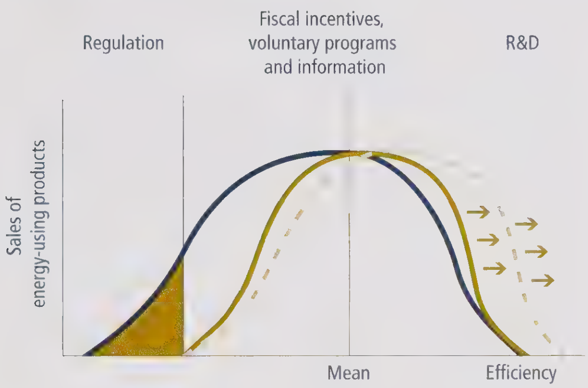
Regulation

The *Energy Efficiency Act* gives the Government of Canada the authority to make and enforce regulations concerning EAE, primarily performance and labelling requirements for energy-using products (as well as doors and windows) that are imported or shipped from province to province.

Figure 1-1 shows how these policy tools work together to increase energy efficiency, i.e. how they help to reduce the amount of energy needed to obtain a certain level of service. R&D increases the opportunities for achieving greater levels of efficiency in a particular type of energy use. Non-R&D measures increase the take-up of existing opportunities to use energy more efficiently. Energy performance regulations eliminate less-efficient products from the market.

FIGURE 1-1

Moving the Market



Compliance with Regulations, 2003–2004

The *Energy Efficiency Act*, passed in Parliament in 1992, provides for the making and enforcement of regulations concerning minimum energy performance levels for energy-using products, as well as the labelling of energy-using products and the collection of data on energy use. The first *Energy Efficiency Regulations* (the Regulations) came into force in 1995 and have established energy efficiency standards for a wide range of energy-using products. They apply to prescribed energy-using products imported into Canada or manufactured in Canada and shipped from one province to another for the purposes of lease or sale. Since 1995, there have been several amendments to the Regulations. NRCan is continually looking to improve the energy efficiency of energy-using equipment in Canada.

The Regulations are described further in Chapters 4, 5 and 6 of this report, with an emphasis on their contribution to energy efficiency in the housing, building and industrial sectors, respectively. The Regulations prescribe a number of obligations for dealers who import into Canada or ship from one Canadian province to another any prescribed energy-using product. NRCan is committed to securing voluntary compliance but can use a range of enforcement measures, when necessary.

NRCan emphasizes self-monitoring, reporting, voluntary compliance and collaboration; however, enforcement measures can be used if dealers violate the law. Enforcement activities include preventing products that do not meet the prescribed energy efficiency standard from entering Canada and preventing the sale or lease of non-compliant product in Canada. Violators can be fined under the Canada Border Services Agency's Administrative Monetary Penalty System for not providing required information on the prescribed product at the time of import, and systematic violations can be prosecuted under the *Energy Efficiency Act*.

Key achievements for 2003–2004 with respect to compliance are as follows:

- Over 350 000 records relating to the importation into Canada were processed.
- Over 38 000 new or revised model numbers were entered into NRCan's compliance database from energy efficiency reports received from dealers.
- New processes to facilitate the updating of energy efficiency report submissions and to enable the processing of greater amounts of data in the database were implemented. New reporting forms were developed for regulated products to facilitate reporting of energy efficiency information by dealers and manufacturers. New batch import procedures were put in place to allow new energy efficiency data submissions to be processed more efficiently and in a timely manner. As a result of these improvements, the accuracy of the data that NRCan is capturing and the monitoring capabilities of the system increased.
- Dealer, manufacturer and importer communities were informed about new regulations affecting vented gas fireplaces in the Regulations.
- Instances of non-compliance were handled on a case-by-case basis in accordance with the Compliance Policy (the major activity being dealer, manufacturer and importer education of the requirements of the Regulations).

Chapter 2: Trends in Energy Use

Introduction

Canadians enjoy an abundance of energy from a variety of sources. This comparative advantage in the supply of energy helps Canadians deal with the economic disadvantages of small domestic markets, long distances, rugged geography and a relatively harsh climate. It also has favoured the development of industries that have a particularly strong energy demand.

Canadians spend almost $114 billion per year on energy to heat and cool their homes and offices and to operate their appliances, cars and industrial processes. This represents 10 percent of the country's gross domestic product (GDP).

Energy Use and Greenhouse Gas Emissions

There are two general types of energy use: primary and secondary. Primary energy use encompasses the total requirements for all users of energy, the energy required to transform one energy form to another (e.g. coal to electricity) and the energy used to bring energy supplies to the consumer. Secondary energy use is energy used by final consumers for residential, agricultural, commercial/institutional, industrial and transportation purposes.

Primary energy use in Canada today reflects changes over several decades in energy-consuming equipment and buildings and in the behaviour of energy users. Primary energy use increased by 21.5 percent between 1990 and 2002, from 9780 petajoules to 11 884 petajoules.

Secondary energy use (8217 petajoules) accounted for 69.1 percent of primary energy use in 2002. It was responsible for 66.2 percent (482 megatonnes) of total greenhouse gas (GHG) emissions in Canada, if indirect emissions – namely, those produced by electric utilities to meet end-use electrical demand – are included.

This report deals with energy-related GHG emissions, which comprise carbon dioxide (CO_2), methane and nitrous oxide. CO_2 represents the majority of Canada's GHG emissions. All subsequent references in this report to CO_2 and GHGs include emissions that are attributable directly to secondary energy use and indirect emissions attributable to electricity generation, unless otherwise specified.

From 1990 to 2002, secondary energy use increased 18.2 percent and related GHG emissions increased by 18.3 percent. The GHG intensity of energy changed slightly during the period as fuel switching towards less GHG-intensive fuels offset a higher GHG intensity in electricity production. The industrial sector is the largest energy user, accounting for 38.7 percent of total secondary energy use in 2002. The transportation sector is the second largest energy user at 28.1 percent, followed by the residential sector at 17.0 percent, the commercial/institutional sector at 13.8 percent and the agriculture sector at 2.5 percent.

Energy Intensity / Energy Efficiency

Aggregate energy intensity is the ratio of energy use per unit of GDP or, alternatively, energy use per capita. Aggregate energy intensity is sometimes used as a proxy for energy efficiency because it is simple, straightforward and the data for the calculation are readily available.

However this measure is misleading because, in addition to pure energy efficiency, intensity captures the impacts of weather variations and changes in the structure of the economy, among other things.

To properly gauge changes in energy efficiency over time, differences in economic structure and weather need to be normalized or factored out of the intensity calculation. Natural Resources Canada's (NRCan's) Office of Energy Efficiency (OEE) applies an internationally recognized factorization analysis technique to isolate the impact of energy efficiency on changes in Canadian energy use.

Figure 2-1 compares, for Canada, an index of annual variation in energy intensity with the OEE's index of changes in energy efficiency over the period 1990 to 2002. The indexes present improvements in energy intensity and efficiency as a downward trend.

TABLE 2-1

Energy Intensities for Selected IEA Countries

GJ* per capita		GJ per $1,000 of GDP	
Luxembourg	355.7	Czech Republic	18.8
Canada	249.2	Hungary	13.2
United States	225.6	Turkey	11.4
Finland	203.6	Canada	10.8
Norway	196.4	Korea	8.5
Belgium	175.4	New Zealand	8.1
Sweden	164.0	United States	7.2
Netherlands	157.3	Australia	6.5
Australia	157.0	Finland	6.3
New Zealand	149.3	Portugal	6.3

*Gigajoules

International Comparisons

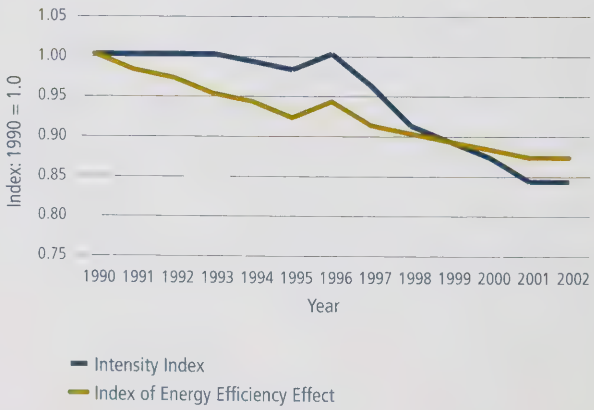
Canada has a higher aggregate intensity – absolute energy use per capita or per unit of GDP – than most International Energy Agency (IEA) countries, ranking second and fourth, respectively.

Meaningful comparisons of energy efficiency between countries can be difficult because very detailed energy, equipment stock, production and/or weather data for each target country are required.

However, according to a recent IEA report entitled *Oil Crises and Climate Challenges – 30 Years of Energy Use in IEA Countries*, Canada's energy efficiency improved at an average annual rate of 1 percent between 1990 and 1998, similar to the rate recorded by the United States, and the fourth fastest rate of improvement among the 13 countries included in the report (surpassed by Finland, Italy and Norway).

FIGURE 2-1

Canada: Changes in Energy Intensity and the Energy Efficiency Effect, 1990–2002



Trends in Energy Efficiency

NRCan annually publishes *Energy Efficiency Trends in Canada*, which reports on changes in energy use (and GHG emissions) and the contribution of the following key factors to these changes:

- Increases in sector **activity** lead to increased energy use and emissions. In the residential sector, for example, an increase in the number of households results in increased energy use.
- Fluctuations in **weather** lead to changes in space-heating and space-cooling requirements. A colder winter or a warmer summer can lead to increased energy use.
- A shift in the **structure** of activity toward more energy-intensive components of activity leads to increased energy use and emissions. For example, if the distribution of activity in the industrial sector shifts from forestry to the iron and steel industry, industrial energy use will increase because the former sector is less energy intensive than the latter.
- A higher **service level** for end-uses such as auxiliary equipment (e.g. computers, fax machines and photocopiers) and air conditioning increased energy use and emissions. This factor is only applied to commercial/institutional buildings. During the 1990s, these types of equipment were widely adopted; however, improvements in functionality increased productivity and moderated increases in energy consumption due to the use of more machines.
- Improvements in **energy efficiency** result in less energy being consumed, for example, how long an appliance can be operated with a given amount of energy.

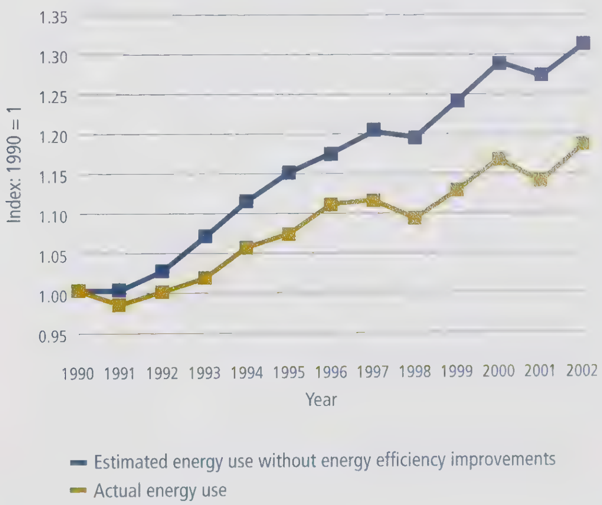
In this report, changes in energy efficiency are the net result after allowing for the changes in energy use due to changes in activity, weather, structure and service level. To the extent that other factors that affect energy use have not been captured, this measure of energy efficiency improvement might overstate or understate the "actual" change. For example, in the industrial sector, there may have been changes in energy use due to shifts in the mix of products, but this is not captured.

Secondary energy use increased between 1990 and 2002 (from 6950 to 8217 petajoules). Without improvements in energy efficiency, increases attributable to activity, weather, structure and service level would have led to an increase in secondary energy use of 30.9 percent. However, as a result of a 12.7 percent (881 petajoules) improvement in energy efficiency, actual secondary energy use increased by 18.2 percent (8217 petajoules).

The change in energy use between 1990 and 2002, actual and without energy efficiency improvements, is shown in Figure 2-2. The difference in energy use due to energy efficiency – the estimated energy saving – represents a reduction in energy costs of $11.6 billion in 2002 and a reduction in GHG emissions of almost 50 megatonnes. Changes in energy efficiency are estimated for each of the four major end-use sectors and are presented in Chapters 4 to 7. The energy efficiency improvements were largest in the residential sector (19.8 percent), followed by the industrial sector (14.2 percent), transportation sector (9.9 percent) and commercial/institutional sector (7.3 percent).[1]

FIGURE 2-2

Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002



[1] The aggregate energy-use data presented in this report are taken from Statistics Canada's *Report on Energy Supply–Demand in Canada* (RESD). Differences exist between this report and *Canada's Emissions Outlook: An Update* (CEO Update) concerning the sector allocations of RESD energy use data. The CEO Update's sector allocation is based on Environment Canada's *Trends in Canada's Greenhouse Gas Emissions 1990–1997*, whereas this report uses a definition better suited for energy end-use analysis. Some modifications to the original Statistics Canada data were required and are documented in Appendix A of Natural Resources Canada's *Energy Use Data Handbook, 1990 and 1996 to 2002*.

TABLE 2-2

Explanation of Changes in Secondary Energy Use, 1990 to 2002

	Sectors						
	Residential	Commercial/ Institutional	Industrial	Transportation	Agriculture	Total	% Change
1990 energy use (PJ)	1288.9	867.0	2717.4	1877.9	199.2	6950.4	
2002 energy use (PJ)	1399.4	1130.1	3176.1	2306.0	205.7	8217.2	
Change in energy use (PJ)	110.4	263.1	458.6	428.1	6.5	1266.8	18.2%
Explanatory Factor (change due to)							
Activity	302.0	231.0	1182.5	411.7		2127.2	30.6%
Weather	21.4	26.5	n/a	n/a		47.9	0.7%
Structure	41.8	11.4	-337.9	165.3		-119.4	-1.7%
Service level	n/a	57.7	n/a	n/a		57.7	0.8%
Energy efficiency	-254.8	-62.3	-386.0	-177.6		-880.7	-12.7%
Other factors		-1.1		28.7	6.5	34.1	0.5%

Trends in Renewable Energy

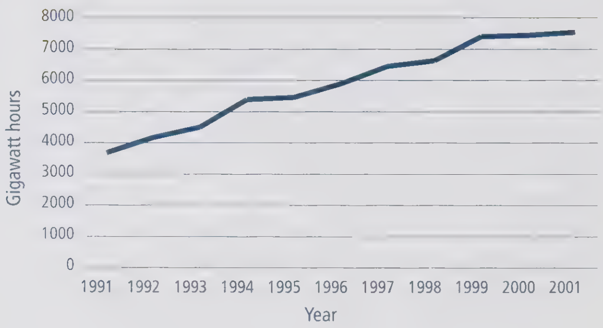
Although in the near term this can be achieved by moving from more to less GHG-intensive fuels (e.g. from coal to natural gas), over the longer term the use of renewable energy sources is expected to accelerate this trend.

Figure 2-3 shows the trend in the use in Canada of electricity generated from wind, solar and biomass, indicating a 204 percent increase over 1991–2001. Although representing only a small component of overall electricity use, the proportion of electricity generated from these renewable energy sources increased from 0.75 percent to 1.32 percent over the period, representing a 57 percent increase in its share. Most of this production was derived from biomass.

The graph does not include hydro sources, either conventional or small (less than 20 megawatts). The former accounts for about 60 percent of electricity generated in Canada; installed capacity is over 62 gigawatts. There are over 230 small hydro installations in Canada, with a total capacity of about 1500 megawatts.

FIGURE 2-3

Electricity Production From Renewable Sources



Chapter 3: Measuring Progress

Introduction

The primary goal of Natural Resources Canada's (NRCan's) efficiency and alternative energy initiatives is to change energy consumption patterns to obtain environmental and economic benefits. Part of assessing program progress and performance involves considering both program delivery and program effectiveness.

In the past, NRCan has focused on the monitoring and tracking of the following three aspects of program delivery:

- program outputs
- program outcomes
- market outcomes

Program outputs are the items produced regularly, such as information and marketing materials, demonstration projects, financial incentives and regulations. Program outputs are designed to lead to **program outcomes** – namely, changes in the behaviour of groups targeted by a program. These groups may be either energy users or producers of energy-using equipment or structures. For example, program outcomes occur when consumers purchase more energy-efficient appliances than they would have if there were no program. Other important factors that influence consumer behaviour include product price, household income, personal taste and other government and non-government programs.

Since program outcomes can directly affect the amount and type of energy consumed in the market, they contribute, in part, to observable **market outcomes**. Market outcomes ultimately reflect the impacts of NRCan programs on changes in energy efficiency, energy intensity, greenhouse gas (GHG) emissions and the use of alternative energy. In this sense, achievement of a targeted market outcome, or observable progress towards a market outcome, serves as an indicator of program effectiveness. An example of a program outcome that leads to a market outcome is a householder's purchase of a more energy-efficient appliance and reduced use of electricity. Depending on the source of electricity and how the utility changes its electricity-generating methods to meet the change in demand that results from reduced electricity use, this could also lead to a decline in GHG emissions.

Focusing on Results

The government-wide initiative aimed at "managing for results" has encouraged management in all federal departments and agencies to focus more on the impacts and effects of their programs and services on the lives of Canadians. Managing for results requires more than just the monitoring of program delivery; it means clearly defining the results to be achieved, increasing the emphasis on program and market outcomes, measuring and evaluating program performance, and making adjustments to improve both the efficiency and effectiveness of programs. It also means reporting on performance in ways that make sense to Canadians.

This report uses a mix of progress indicators, which are quantitative where possible. The challenge for NRCan is to continuously improve the coverage and quality of these progress indicators, both in general and in order to ensure that they increasingly reflect a focus on results. The following section highlights some of NRCan's efforts to improve the quality of its program performance information through better data collection and data analysis.

Data Collection and Analysis

In 1991, NRCan launched the National Energy Use Database (NEUD) initiative to help the department improve its knowledge of energy consumption and energy efficiency at the end-use level in Canada, and to support NRCan's analytical expertise. The NEUD initiative plays a number of crucial roles directly related to NRCan program activities; however, its most important roles are to secure the development of a reliable, Canada-wide information base on energy consumption at the end-use level for all energy-consuming sectors, and to perform analyses related to energy efficiency program performances.

The NEUD initiative consists of several broad components that typically involve conducting large- and small-scale surveys of the stocks and characteristics of energy-using equipment and buildings, observing consumer behaviour with respect to energy use, monitoring the adoption of new technologies in the market place and participating in the development of energy end-use data and analysis centres (DACs) across Canada.

The main objective of the DACs is to create a base of expertise for the analysis of energy consumption at the end-use level in Canada. The DACs are mandated to improve the accessibility and comparability of existing data on the evolution of energy consumption and its impact on environmental quality. Three DACs currently exist: the transportation centre at Université Laval in Québec City, Quebec; the industrial centre at Simon Fraser University in Burnaby, British Columbia; and the buildings centre at University of Alberta in Edmonton, Alberta.

The centres have made significant contributions to NEUD's mandate of improving knowledge of energy consumption and energy efficiency at the end-use level in Canada. For example, in 2003–2004, the transportation centre at Université Laval, using a discrete choice model, conducted an analysis on the impact of the EnerGuide sticker for new vehicles on consumers' purchase behaviour.

Chapter 4: Housing

Energy Use and Greenhouse Gas Emissions

The residential sector includes four major types of dwellings: single detached, single attached, apartments and mobile homes. Energy is used in dwellings for space heating and cooling, heating water, and operating appliances, electronic equipment and lights. This sector accounts for 17 percent (1399 petajoules) of secondary energy use and 15.6 percent (75 megatonnes) of greenhouse gas (GHG) emissions.

Most dwellings in Canada are single detached houses, followed by apartments, single attached dwellings and mobile homes (see Figure 4-1). Because single detached and attached houses predominate, most Natural Resources Canada (NRCan) residential building programs focus on these types of dwellings.

Space and water heating make up 81 percent of residential energy use, followed by the shares devoted to operating appliances, lighting and space cooling (see Figure 4-2).

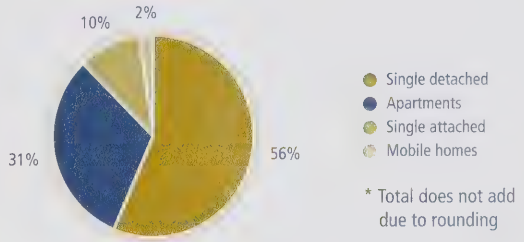
Between 1990 and 2002, residential energy use increased by 8.6 percent, or 110 petajoules (from 1289 to 1399 petajoules). From 1990 to 2002, GHG emissions from the residential sector increased by 8.4 percent. GHG intensity changed little because fuel switching towards less GHG-intensive fuels offset an increase in the GHG intensity of electricity production over the period.

Four main factors tended to influence residential energy use – activity, weather, structure and energy efficiency:

- activity – the increase in the number of households and the size of dwellings (the principal measures of residential activity) increased energy use by 23.4 percent (302 petajoules)
- weather – a colder winter and a warmer summer in 2002 compared with 1990 led to an increase in space-conditioning requirement; this increased energy use by 1.7 percent (21 petajoules)
- structure – the percentage shares of energy end-uses changed over the period such that they increased energy use by 3.2 percent (42 petajoules)
- energy efficiency – improvements in energy efficiency decreased energy use by 19.8 percent (255 petajoules)

FIGURE 4-1

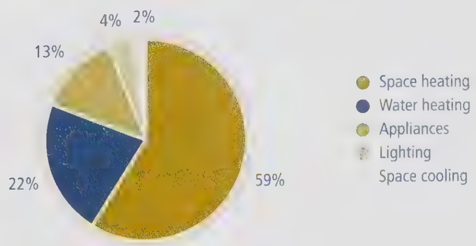
Canadian Households by Type of Dwelling, 2002*



* Total does not add due to rounding

FIGURE 4-2

Residential Energy Use by Purpose, 2002



Growth in residential energy use was driven in large part by growth in activity. This increase was partially offset by significant improvements in energy efficiency. Structural changes had a minor impact on residential energy use.

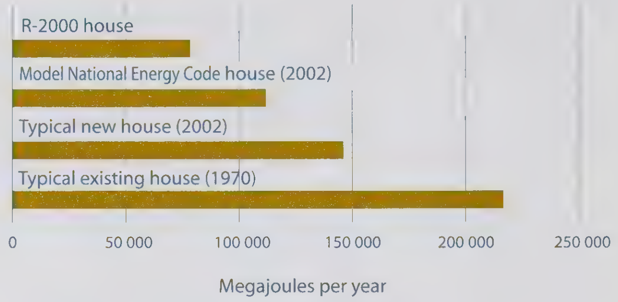
The change in overall residential energy use from the years 1990 to 2002, as well as the estimated energy savings due to energy efficiency, is shown in Figure 4-3. Figures 4-4 and 4-5 show how energy consumption differs for houses built to different standards and in different periods, reflecting improvements in building construction.

NRCan delivers initiatives to increase energy efficiency in the following residential sub-sectors:

- new houses
- existing houses
- residential equipment

FIGURE 4-4

EnerGuide Rating for Houses Annual Heating Consumption for Houses* Constructed to Different Standards



* 198-m² one-storey, single detached house heated with natural gas, Ottawa, Ontario

Figure 4-3

Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002

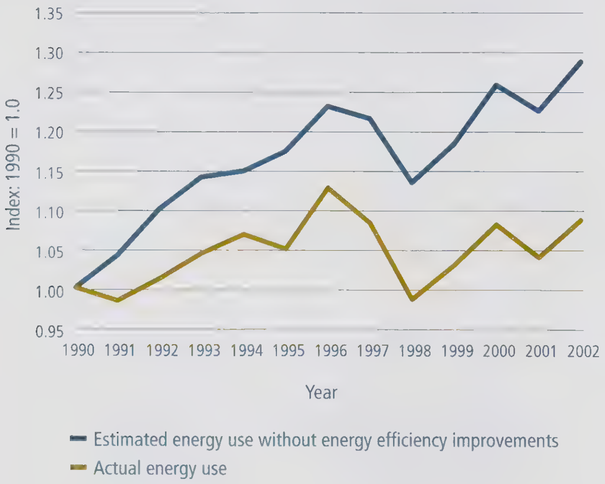
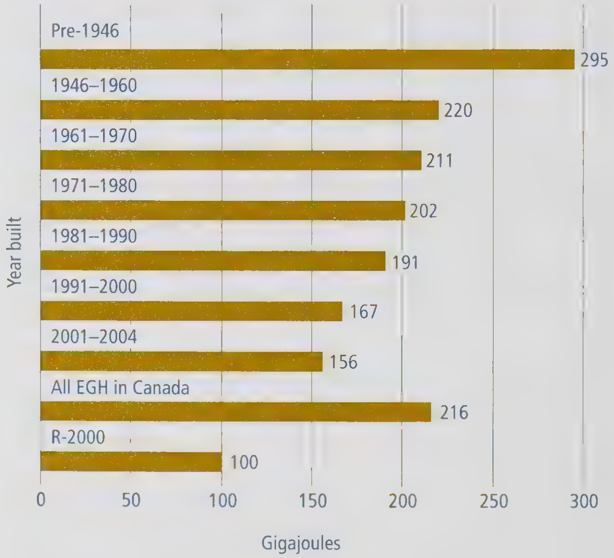


FIGURE 4-5

Average Energy Consumption per Household*, Pre-1946 to 2001–2004



* From R-2000 and EnerGuide for Houses programs

New Houses: R-2000 Standard and EnerGuide for (New) Houses

Objective: To increase market adoption of energy-efficient new houses by promoting changes in construction practices and by labelling houses for energy performance.

The R-2000 Standard is a voluntary technical performance standard that encourages Canadian builders to build, and Canadian consumers to purchase, houses that are more energy efficient and environmentally responsible than is required by current Canadian building codes. NRCan trains and licenses R-2000 homebuilders and other professionals in R-2000 Standard construction techniques and practices, and provides third-party quality assurance by testing and certifying R-2000 homes.

EnerGuide for (New) Houses is an energy-performance rating and labelling scheme designed to encourage the industry to build, and consumers to purchase, more energy-efficient houses. The EnerGuide for Houses (EGH) scheme is based on the R-2000 Standard and training, and it targets large-volume, mass-market builders.

Key 2003–2004 Achievements

- Over 1000 industry professionals received training in R-2000 construction techniques and the sizing and installation of high-efficiency heating and ventilation systems.
- EnerGuide for (New) Houses rating scheme was launched and has been chosen for inclusion in Built Green™ Alberta and Manitoba Power Smart house initiatives.
- Successfully launched the Building Canada initiative, aimed at recruiting and training key, very large-volume builders to construct and EGH-label energy-efficient houses.

For more information:
oee.nrcan.gc.ca/r-2000/english/index.cfm

R-2000 is an official mark of Natural Resources Canada.

FIGURE 4-6

Number of Eligible R-2000 Housing Starts, 1990 to 2003

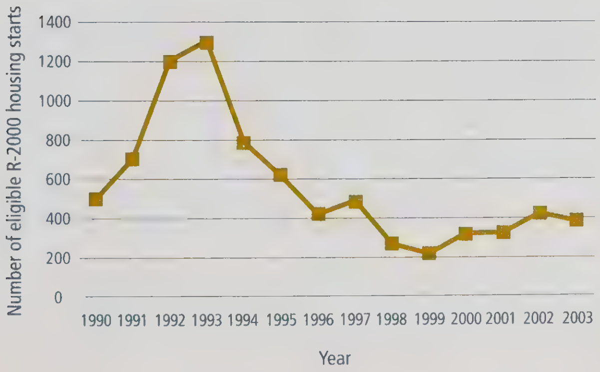
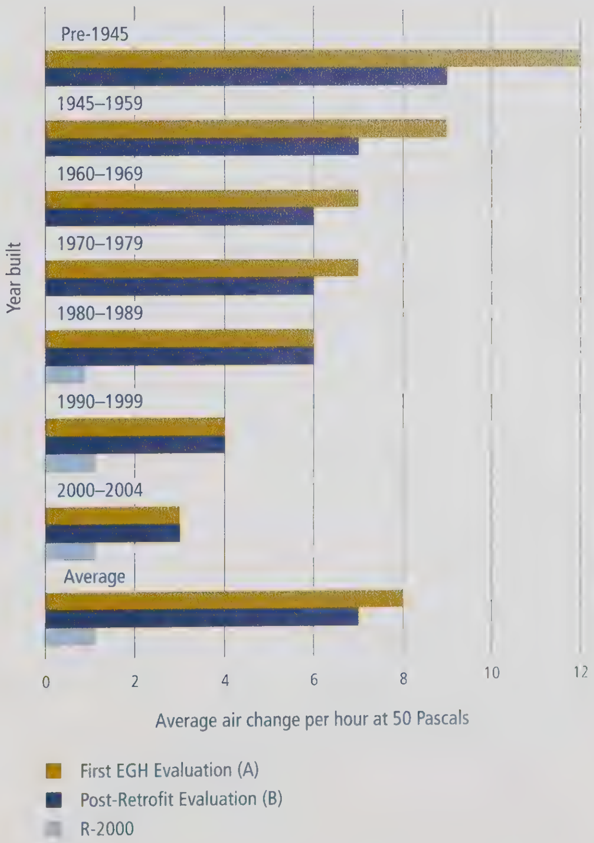


FIGURE 4-7

National Trends in Air Leakage (R-2000 and EnerGuide for Houses), Pre-1945 to 2000–2004



New Houses: Super E™ House Program

Objective: To build capacity for exporting energy-efficient, durable and environmentally friendly Canadian housing technology to foreign markets.

The Super E™ House Program is a strategic housing export initiative delivered by NRCan as part of the Team Canada export strategy. The program adapts internationally leading Canadian energy efficiency standards to foreign markets and identifies appropriate technologies for them, to create unique market opportunities for Canadian housing technology companies. Launched in 1998, the Super E House Program has facilitated partnerships between Canadian builders and their foreign counterparts to increase market penetration of Canadian energy-efficient technologies internationally.

The Super E U.K. program is financed by the CANMET Energy Technology Centre (CETC), the Canada Mortgage and Housing Corporation (CMHC) and the Canadian Forest Service (CFS). The Super E Japanese program is financed by CETC and CMHC. In both cases, there is strong support from the Department of Foreign Affairs and International Trade (now divided into Foreign Affairs Canada and International Trade Canada). The Super E U.K. Industry Consortium now comprises 11 Canadian and 15 U.K./Irish companies, and the Super E Japan program comprises 13 Canadian companies and 25 Japanese partners.

The Super E U.K. program has registered 92 units completed, generating $9.2 million of revenue to Canadian companies with confirmed Super E orders of 43 additional units valuing at $4.3 million. The Super E Japan program has registered 91 units completed, generating $7 million of revenue to Canadian companies. In both countries, Super E is now established as high quality housing uniquely available from Canada and its exporters.

Key 2003–2004 Achievements

- Established a not-for-profit organization, the Energy Efficient Exporters Alliance, to administer and represent industry interests for the Super E House Program.
- Secured major funding until 2007 from the CFS through the Canada Wood Export Program to continue to promote and develop the market in the U.K. for Super E.
- Signed new Super E agreements and house openings in London, U.K., presided over by CMHC Secretary of State.
- Secured a Super E Project in China (by CMHC).

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

Super E is an official mark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

Existing Houses: EnerGuide for Houses and Retrofit Incentives

Objective: To encourage Canadians to improve the energy efficiency of their homes.

EnerGuide for Houses (EGH) provides Canadian homeowners with personalized expert advice on how to best improve the energy performance of their houses, especially when undertaking renovation and maintenance projects. Under EGH, a retrofit incentive was officially launched in October 2003. Homeowners can now qualify for a non-taxable grant, which represents about 10 to 20 percent of their expenditures, when they retrofit their homes. The grant is based on the differential improvement in the house's energy rating, as measured by a pre- and post-renovation EGH energy evaluation.

Key 2003–2004 Achievements

- Over 48 000 houses evaluated and labelled.
- Issued 2145 grants, totalling $1.3 million. These grants were paid to homeowners between the October 2003 launch and the end of the fiscal year. Grants are currently being paid in under 60 days.
- Reduced energy consumption by between 20 and 38 percent in post-retrofit homes; grant recipients reduced carbon dioxide (CO_2) by an average of 4 tonnes per year, per house.

For more information:
oee.nrcan.gc.ca/residential/personal/index.cfm

FIGURE 4-8

Evaluations Under EnerGuide for Houses, 1998–1999 to 2003–2004

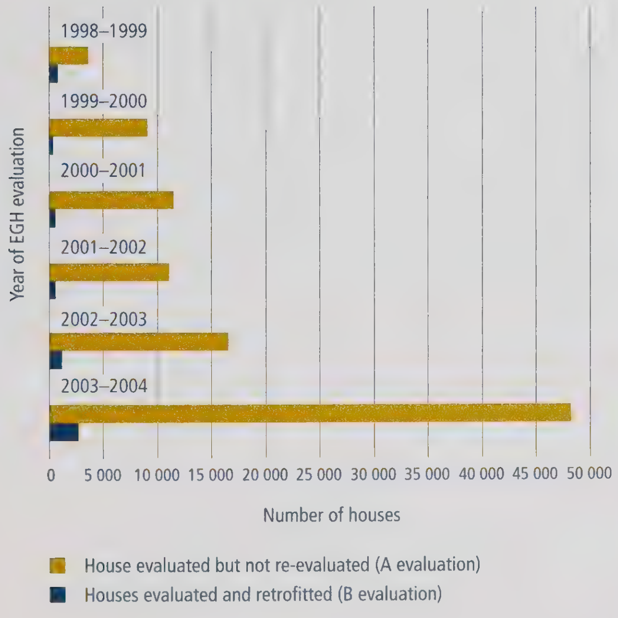
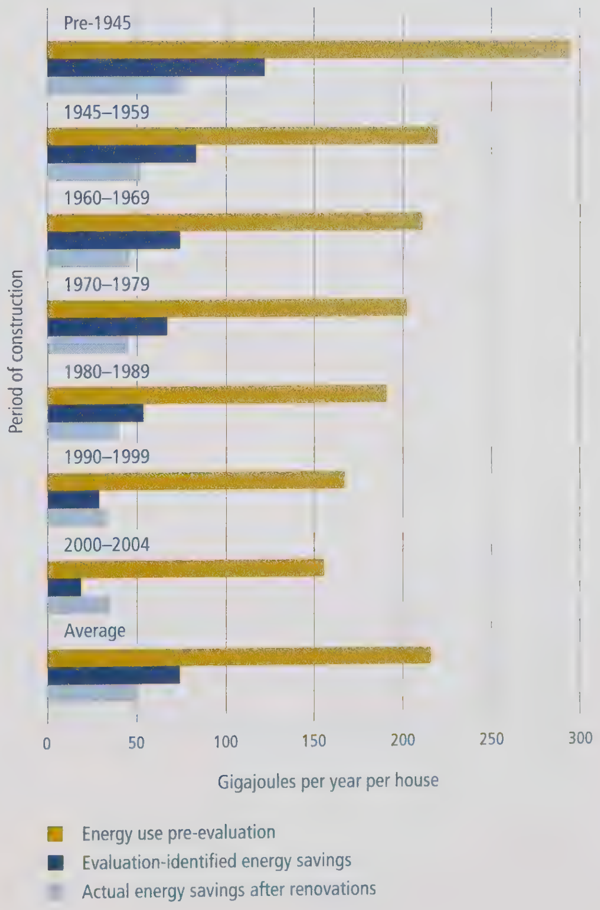


FIGURE 4-9

Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2004



Residential Equipment: Energy Efficiency Standards and Regulations

Objective: To eliminate the less energy-efficient models of energy-using equipment from the market through minimum performance regulations under the *Energy Efficiency Act.*

The *Energy Efficiency Regulations* incorporate national consensus performance standards that include testing procedures to determine the energy performance of the equipment. They prohibit imports of, or interprovincial trade in, prescribed products that fail to meet minimum energy-performance levels and labelling requirements.

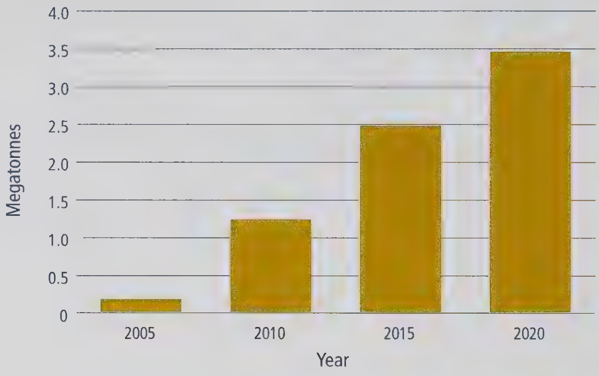
Key 2003–2004 Achievements

- Pre-published eighth amendment to the *Energy Efficiency Regulations* to increase the minimum energy performance standards in the residential sector for clothes washers and gas-fired and electric storage water heaters. Estimated reductions in CO_2 emissions in the residential sector from this amendment are shown in Figure 4-10.
- The cumulative annual reductions in CO_2 emissions resulting from the aggregate energy savings attributable to the eighth amendment to the *Energy Efficiency Regulations* in the residential sector are estimated to be approximately 0.17 megatonnes in the year 2005 and 3.44 megatonnes in the year 2020.

For more information:
oee.nrcan.gc.ca/regulations/home_page.cfm

FIGURE 4-10

Eighth Amendment: Estimated Reductions in CO_2 Emissions, 2005 to 2020



Residential Equipment: Labelling and Promotion

Objective: To promote the production, purchase and use of more energy-efficient equipment.

The Labelling and Promotion Initiative consists of labelling, rating and promotional activities that encourage manufacturers to produce, and consumers to purchase, more efficient energy-using equipment. The initiative consists of EnerGuide for Equipment, which provides comparative information on the energy performance of major household appliances as well as heating, ventilating and air-conditioning (HVAC) equipment, and the administration in Canada of the international ENERGY STAR® label, which allows the consumer to identify the most energy-efficient products available based on a standard set of criteria. Activities range from ensuring that ENERGY STAR® products are well-identified and available for Canadians to buy, to promoting the symbol in catalogues and Web sites, to developing specific initiatives around ENERGY STAR® qualified products.

Key 2003–2004 Achievements

- Newspaper articles featuring EnerGuide had the second largest pick-up in national and community newspapers.
- Implemented Canada-specific ENERGY STAR® criteria for windows and sliding glass doors sold in Canada.
- Recruited over 140 organizations to participate in and promote ENERGY STAR® in Canada. Many retailers across Canada, including Sears Canada Inc., the Hudson's Bay Company and The Home Depot, Inc. have featured ENERGY STAR® products in their flyers. Specifically, Home Depot has organized retail activities promoting its ENERGY STAR® qualified products, entitled "EnergyWise – Au Courant."
- Use of the ENERGY STAR® high efficiency levels by provinces and utilities as the qualifying level for rebates and incentives. Specifically, Saskatchewan and Ontario have used ENERGY STAR® to qualify high efficiency appliances for provincial sales tax rebates.
- Many gas utilities – Terasen Inc. in British Columbia, SaskEnergy Incorporated in Saskatchewan, Union Gas Limited and Enbridge Gas Distribution in Ontario, Heritage Gas Limited in Nova Scotia and Enbridge Gas New Brunswick in New Brunswick – have specified the ENERGY STAR® high efficiency level for incentives for gas furnaces and boilers. Climate Change Central in Alberta also used the ENERGY STAR® levels to qualify for rebates on high efficiency gas furnaces and boilers. In all, approximately 18 000 new gas furnaces and boilers qualifying for ENERGY STAR® have included incentives or rebates from these programs across Canada. Projects with Terasen and Union Gas have additionally included a rebate to encourage the installation of high efficiency gas furnaces with variable speed, high efficiency fan motors, which addresses the electricity consumption portion of these appliances. SaskEnergy has set up an ENERGY STAR® Loan Program where consumers who purchase ENERGY STAR® qualified gas heating systems would get zero percent financing. The province of New Brunswick announced that government procurement practices include specifying ENERGY STAR® qualified products where feasible and practical.

For more information:
energuide.gc.ca
oee.nrcan.gc.ca/equipment
energystar.gc.ca

FIGURE 4-11

ENERGY STAR® Label

FIGURE 4-12

Average Energy Consumption of New Appliances, 1990 and 2002 Models

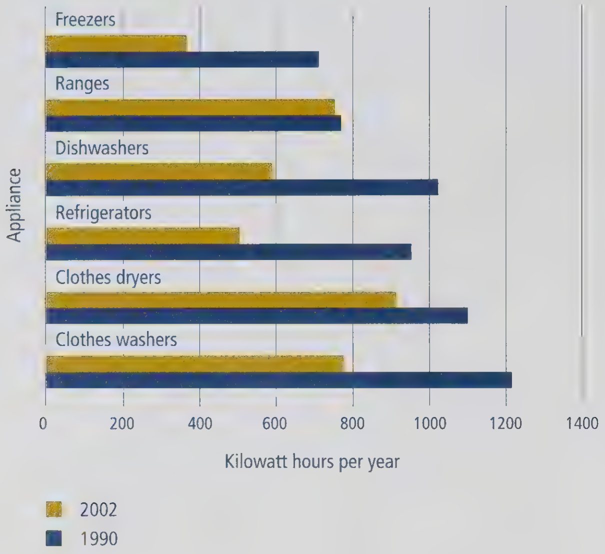


FIGURE 4-13

Unit Energy Consumption for Top-Mounted Auto-Defrost Refrigerators Marketed in Canada, 1991 and 2004 Models

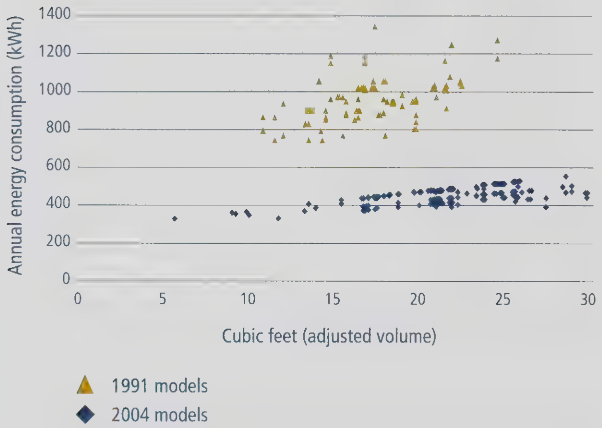
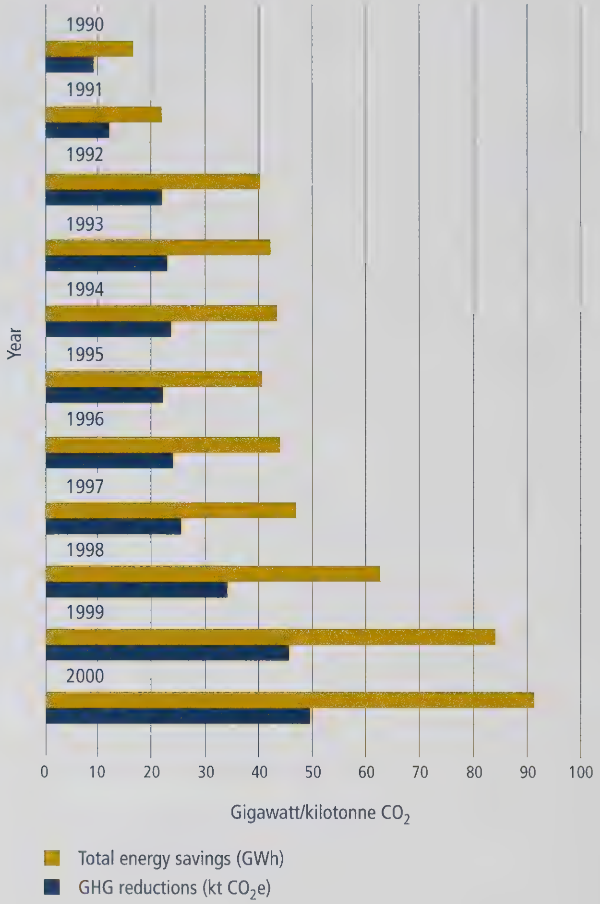


FIGURE 4-14

Impact of EnerGuide Labelling: Total Energy Savings and GHG Emissions Reductions Attributable to the EnerGuide for Equipment Program, 1990 to 2000



Residential Equipment: Housing Energy Technology Program

Objective: To accelerate the development and market adoption of energy-efficient housing technologies.

Working in partnership with associations, government and industry, the CANMET Energy Technology Centre (CETC) manages this program to develop and deploy highly specialized solutions that help reduce, in a cost-effective manner, the energy consumption and GHG emissions of Canadian houses. Progress to date includes the identification, accelerated development and broader deployment of a number of promising technologies, such as advanced integrated mechanical systems (now trademarked ēKOCOMFORT™) and electronically commutated motors.

In whole house design, the development and technical support of the R-2000 Standard has led to extensive technology development and deployment throughout the housing sector. Through its associated Building Energy Simulation Program, CETC's software tools are widely used to assess the energy use in a home. CETC also develops more energy-efficient frames for windows and is a lead managing agency for the Canadian Centre for Housing Technology (CCHT), an advanced testing facility for assessing whole-house impacts of emerging technologies.

Key 2003–2004 Achievements

- Signed an agreement with a leading Canadian fuel cell developer to test a beta residential fuel cell in a joint project at CCHT. This will be the first residential fuel cell installation in Canada.
- Tested and assessed a distributed generation combined heat and power (CHP) system based on a Stirling engine that was integrated into the heating and electrical systems at CCHT. The system showed good potential for Canadian housing and will be further investigated in 2004–2005.
- Continued to work with the Canadian Standards Association (CSA) to develop a new residential integrated mechanical systems standard based on the test protocol developed by CETC for the ēKOCOMFORT consortium. The Standard will enable the efficiency of integrated products to be recognized and certified.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

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Chapter 5: Buildings

Energy Use and Greenhouse Gas Emissions

The commercial/institutional sector includes activity related to trade, finance, real estate, public administration, education and commercial services, including tourism. This sector uses energy mainly for space and water heating, space cooling, lighting, motive power for services such as pumping and ventilation in buildings, and street lighting.

In 2002, the total commercial/institutional sector accounted for 13.8 percent (1131 petajoules) of secondary energy use and 13.4 percent (64.4 megatonnes) of greenhouse gas (GHG) emissions.

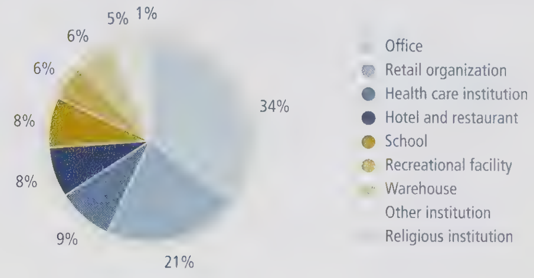
To highlight energy use in buildings, the following analysis excludes energy use for street lighting. The commercial/institutional sector comprises many building types (see Figure 5-1). Retail and office space account for more than half of commercial/institutional sector energy demand. Health care institutions, hotels and restaurants and schools account for another 25 percent of that demand. Natural Resources Canada's (NRCan's) initiatives address all of these major energy-using building types.

Energy is used for six purposes in commercial/institutional buildings. The largest of these is space heating, which accounts for more than half of energy use in this sector (see Figure 5-2). Each of the remaining five uses of energy accounts for between 6 and 13 percent of energy demand in this sector.

Between 1990 and 2002, commercial/institutional energy use, excluding street lighting, increased by 30.8 percent, or 264 petajoules (from 858 to 1122 petajoules). However, GHG emissions from the sector rose by 35.1 percent in the same period. Emissions increased more quickly than energy use due to the increased use of energy sources with a higher GHG content.

FIGURE 5-1

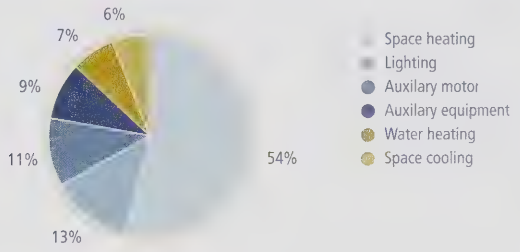
Commercial/Institutional Energy Use by Building Type*, 2002



* Excludes street lighting

FIGURE 5-2

Commercial/Institutional Energy Use by Purpose*, 2002



* Excludes street lighting

Figure 5-3

Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002

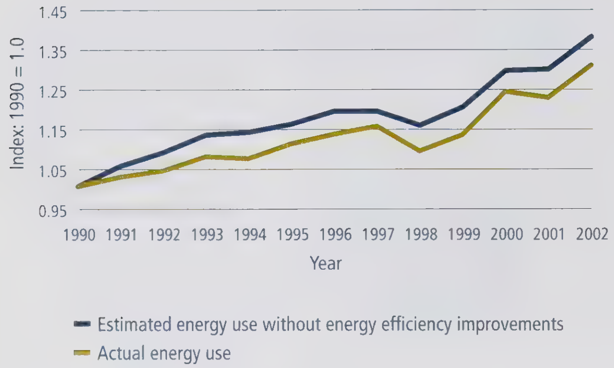
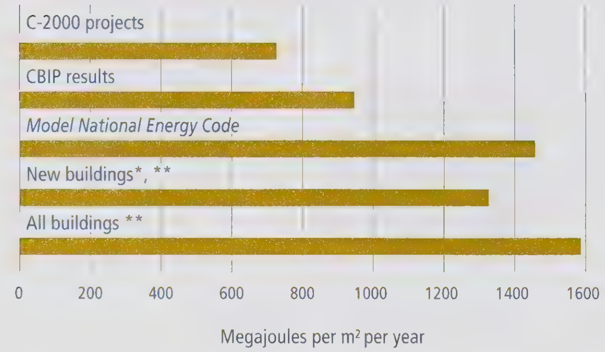


FIGURE 5-4

Energy Use in Commercial Buildings, 2000



* 1990–2000
** Source: Commerical and Institutional Building Energy Use Survey, 2000. Estimates relate only to the surveyed area of populations over 175 000, and in Atlantic Canada to populations over 50 000.

During 1990–2002, a steady increase in activity largely contributed to increased energy use. To a lesser degree, service levels for auxiliary equipment and space cooling, structure (the mix of building types) and weather also each played a role. However, energy efficiency slowed this rate of increase. Specifically, the energy use changes attributed to each of these factors are

- activity – a 26 percent increase in activity resulted in a 231-petajoule increase in energy use
- weather – fluctuations in weather resulted in a 3.1 percent increase in energy use (26 petajoules)
- structure – a shift in activity resulted in a 1.3 percent increase in energy use (11 petajoules)
- service level – a higher service level for end-users resulted in a 6.7 percent increase in energy use (58 petajoules)
- energy efficiency – a 7.3 percent improvement in energy efficiency resulted in a decrease of 62 petajoules

Without improvements in energy efficiency, increases attributable to activity, weather, structure and service level would have led to an increase in commercial/institutional energy use of 38.1 percent (327 petajoules). However, as a result of a 7.3 percent improvement in energy efficiency, actual energy use increased by 30.8 percent. This change in energy use during 1990–2002, as well as the estimated energy savings due to energy efficiency, is shown in Figure 5-3. Figure 5-4 shows how energy use in commercial buildings compares to certain standards.

NRCan delivers initiatives to increase energy efficiency in the following sub-sectors of the commercial/institutional sector:

- new buildings
- existing buildings
- equipment

New Buildings: Commercial Building Incentive Program

Objective: To improve the energy efficiency of new commercial, institutional and multi-unit residential buildings.

The Commercial Building Incentive Program (CBIP) provides financial incentives to builders and developers who incorporate energy-efficient features into the design and construction of new commercial, institutional and multi-unit residential buildings. To qualify for the incentive, buildings must be at least 25 percent more energy efficient than similar buildings constructed to the *Model National Energy Code for Buildings* (MNECB). However, results indicate that CBIP buildings are on average 35 percent better than similar buildings constructed to the MNECB. The program is delivered by the Government of Canada and co-marketed by a number of provincial/territorial utilities, provincial/territorial energy efficiency and climate change agencies, and building professional organizations.

Key 2003–2004 Achievements

- New partnerships formed with Climate Change Central (Alberta) and Gazifère (Quebec). Ongoing partnerships with Enbridge Gas Distribution (Ontario), Gaz Métro (Quebec) and Manitoba Hydro.
- Incentives given to 372 projects since program inception. As a result, 78 kilotonnes of GHG emissions have been avoided.
- CBIP buildings average 34.8 percent more energy efficiency than similar buildings constructed to the MNECB.

For more information:
oee.nrcan.gc.ca/newbuildings

FIGURE 5-5

Estimated Average GHG Reductions by Institution Under CBIP, 2003 to 2004

New Buildings: Industrial Building Incentive Program

Objective: To improve the energy efficiency of new industrial buildings.

The Industrial Building Incentive Program (IBIP) extends the precepts of CBIP to the industrial sector. IBIP offers an incentive to companies building new energy-efficient industrial facilities to offset additional design costs inherent in the initial attempts at energy-efficient designs and building/process integration. The design is assessed against a reference generated from the MNECB.

Key 2003–2004 Achievements

- Six contribution agreements were signed; three of these were for laboratories.
- Seventeen projects provided incentives since program inception.
- Seventeen architects and engineers were trained for energy-efficient industrial building design.
- Modelling guidelines for industrial buildings were completed.
- One design charrette for a printing plant was completed.

For more information:
oee.nrcan.gc.ca/newbuildings

New Buildings: Green Buildings Program

Objective: To reduce energy use, resource consumption and emissions from commercial buildings through design, construction and retrofitting while increasing cost-effectiveness.

The program plays a significant role in establishing goals for energy efficiency and sustainability in commercial buildings through a variety of key activities. Through the C-2000 Program for Advanced Commercial Buildings – a small demonstration program for high-performance buildings – NRCan sets targets for designers to reduce energy consumption by 50 percent and water consumption by 40 percent. It provides the necessary tools, guidelines and techniques through its integrated design process (IDP) to lead design teams to produce optimized, energy-efficient, integrated building designs that fully exploit building component synergies.

The program also provides ongoing support to NRCan programs such as CBIP by developing guidelines, providing technical support and developing downloadable simulation software tools that perform accurate building analysis, assist in design and measure compliance with these incentive programs.

NRCan launched the Green Building Challenge (GBC) in 1996 (now managed by a third party) and established Sustainable Building (SB) conferences to showcase the results and best practices of the competing energy-efficient buildings. GBC brings together more than 20 countries focused on the development and testing of an internationally accepted system for assessing the environmental performance of buildings. The NRCan-developed electronic GBTool™ is used in the assessments.

Key 2003–2004 Achievements

- Award-winning C-2000 building at Red River College, Winnipeg, was featured on the front cover of *Canadian Architect* magazine, highlighting the largest building designed and built under CANMET Energy Technology Centre's (CETC's) C-2000 Program and also the first major adaptive re-use of heritage buildings.
- CETC continued to build capacity for energy-efficient building design by integrating C-2000, the IDP and energy software tools into university/college architecture and building science curricula, as well as through seminars given at the largest construction trade show in Canada (Construct Canada) and by working with municipalities in Alberta and Manitoba and the city of Ottawa.
- The SB'05 Canadian Team was established and Canadian buildings are currently being reviewed and selected for assessments to be presented at the 2005 conference.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

GBTool is a Trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

Existing Buildings: Energy Innovators Initiative

Objective: To encourage commercial businesses and public institutions to become more energy efficient and reduce their GHG emissions that contribute to climate change.

The Energy Innovators Initiative (EII) helps commercial organizations and public institutions explore energy efficiency options and strategies, offering them access to tools and financial assistance to help reduce energy costs and improve competitiveness. Members join the EII by sending a letter to the Minister of Natural Resources from senior management stating their commitment to energy efficiency. Currently, over 1600 commercial, institutional and multi-unit residential organizations across Canada are Energy Innovators.

After joining the EII, members can apply for Energy Retrofit Assistance (ERA) funding for retrofit planning activities and retrofit implementation projects in existing commercial/institutional buildings.

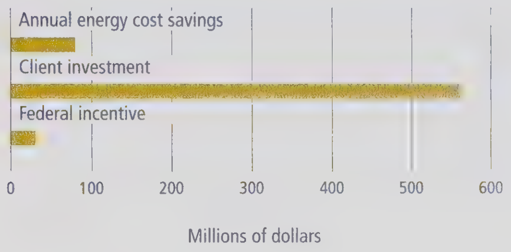
Key 2003–2004 Achievements

- Expanded program to allow more organizations to apply for funding.
- Established 13 formal partnerships with member-based associations through contribution agreements.
- Funded approximately 70 energy retrofit implementation projects and more than 205 retrofit planning activities.

For more information:
oee.nrcan.gc.ca/eii/home.cfm

FIGURE 5-6

Energy Innovators Initiative – Incentive Projects, 1998 to 2004



Equipment: Energy Efficiency Standards and Regulations

Objective: To eliminate the less energy-efficient models of energy-using equipment from the market through minimum performance regulations under the *Energy Efficiency Act*.

The *Energy Efficiency Regulations* incorporate national consensus performance standards that include testing procedures to determine the energy performance of the equipment. They prohibit imports of, or inter-provincial trade in, prescribed products that fail to meet minimum energy-performance levels and labelling requirements.

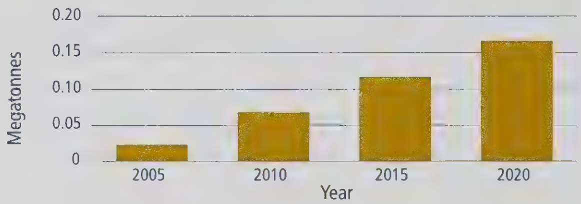
Key 2003–2004 Achievements

- Pre-published eighth amendment to the *Energy Efficiency Regulations* to establish minimum energy performance standards in the commercial sector for water chillers and exit signs. Estimated reductions in carbon dioxide (CO_2) emissions in the commercial sector from this amendment are shown in Figure 5-7.
- The cumulative annual reductions in CO_2 emissions resulting from the aggregate energy savings caused by the eighth amendment to the *Energy Efficiency Regulations* in the commercial sector are estimated to be approximately 0.02 megatonnes in the year 2005 and 0.17 megatonnes in the year 2020.

For more information:
oee.nrcan.gc.ca/regulations/home_page.cfm

FIGURE 5-7

Eighth Amendment: Estimated Reduction in CO_2 Emissions, 2005 to 2020



Equipment: Labelling and Promotion

Objective: To promote the production, purchase and use of more energy-efficient equipment.

The initiative includes EnerGuide for Equipment, which provides comparative information on the energy performance of equipment – including heating, ventilating and air conditioning (HVAC) – and the international ENERGY STAR® label, which allows the consumer to identify the most energy-efficient products available based on a standard set of criteria.

Key 2003–2004 Achievements

- Advertising strategy for gas fireplaces developed to inform consumers about EnerGuide.
- Appliance and room air directories published and sent to major retailers.
- ENERGY STAR® retail brochure produced and distributed.

For more information:
energuide.nrcan.gc.ca
oee.nrcan.gc.ca/equipment
energystar.gc.ca

Equipment: Buildings Program – Refrigeration Systems Equipment

Objective: To support the development and the adoption of innovative refrigeration technologies that reduce energy consumption, synthetic refrigerant use and GHG emissions in commercial and institutional buildings.

The Refrigeration Action Program for Buildings (RAPB) was launched in 2003 under the *Climate Change Plan for Canada* and focuses on the deployment of innovative refrigeration technologies integrated with a building's HVAC systems, in order to drastically reduce refrigerant losses, allow the recovery and upgrade of the heat rejected by the refrigeration system, and adapt the system's operation to the Canadian climate. To meet its objective, the RAPB performs capacity building, demonstration, information and training activities in partnership with key stakeholders, for Canadian supermarkets, ice rinks and curling rinks. The RAPB also undertakes research and development activities on refrigeration technological solutions.

Key 2003–2004 Achievements

- Start-up of a demonstration project of integrated HVAC and refrigeration technologies in the Loblaws supermarket in Repentigny, Quebec, as well as in three ice rinks. In addition, technical fact sheets and feasibility study analysis tool software have been produced.
- The Val-des-Monts ice rink demonstration project received the 2003 Jury's Award at the Energia Competition in Quebec, and was finalist for a Phoenix prize in an environmental competition.
- The CETC–Varennes refrigeration team was the successful bidder and won a research project contract from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the world's most referenced organization related to all aspects of HVAC and refrigeration systems and equipment, to improve Chapter 34 of the 2002 *ASHRAE Refrigeration Handbook* content on the design of ice rink refrigeration systems.

For more information:
cetc-varennes.nrcan.gc.ca/en/ref.html

Equipment: Buildings Program – Intelligent Buildings

Objective: To develop and promote the adoption of intelligent building technologies and innovative building operation practices that reduce energy consumption and GHG emissions.

The program focuses on intelligent building technologies and practices, such as re-commissioning, that reduce a building's energy consumption while ensuring the occupants' comfort and preserving indoor air quality. To meet its objectives, the program develops, demonstrates and deploys, in partnership with key stakeholders, intelligent buildings technologies in Canadian commercial/institutional buildings.

Key 2003–2004 Achievements

- Developed a business case for the use of intelligent building technologies to improve building operation in Canada. The business case demonstrated that building operation optimization can have significant benefits in terms of energy efficiency, GHG emission reductions and improvement of indoor air quality for buildings. DABO, the Diagnostic Agent for Building Operators, developed by CETC–Varennes, is a key element in the persistence of the benefits.
- A new version of DABO with added diagnostic capabilities has been developed and installed at the Montréal – Pierre Elliott Trudeau International Airport in Dorval, Quebec; the Federal Training Centre in Laval, Quebec; and the Arena of Amqui, Quebec; as well as at the headquarters of Delta Controls Inc. in Surrey, British Columbia.

For more information:
cetc-varennes.nrcan.gc.ca/en/b_b/bi_ib.html

Equipment: Building Energy – Simulation Program

Objective: To contribute to the improvement of design, performance, cost-effectiveness, integration and deployment of energy-efficient building technologies and techniques, through simulation modelling and applications-driven implementation tools for the market.

Through this program, the Simulation Team develops, distributes and supports building simulation software for the Canadian housing and building industry. These software tools are used by architects and engineers to optimize the energy performance of individual technologies and whole building designs, as well as to demonstrate compliance with such programs as the R-2000 Standard, EnerGuide for Houses and (New) Houses, CBIP, the *Model National Energy Code for Buildings* and the *Model National Energy Code for Houses*. The team is involved in all aspects of the software development process, from design and programming to distribution, maintenance, and user training and support.

The Simulation Team developed the next generation residential energy analysis software, HOT3000™, a more advanced version of HOT2000™, with a more comprehensive and expandable simulation engine (based on the ESP-r program). HOT3000 is capable of expanding to meet the complexities of the energy-saving technologies and strategies entering the market and emerging in industry research and development. The ESP-r program was created by the University of Strathclyde in Scotland and modified by CETC to meet Canadian simulation needs. The University of Strathclyde remains a collaborator on several simulation software development projects.

Key 2003–2004 Achievements

- Became first in the world to have a fuel cell model integrated into a whole-building simulation program. This model is an important tool for analysing and studying distributed generation systems for buildings.
- Established and chairs a research annex on the modelling of residential cogeneration systems under the International Energy Agency, taking a lead role internationally in the development and validation of methods for modelling fuel cell and other cogeneration systems.
- Using CETC software, over 128 000 houses and 380 commercial buildings have been simulated for improved energy efficiency to date.
- Delivered full-day training courses on the ESP-r/HOT3000 simulation engine to graduate students sponsored by the University Research Network, as well as to university professors and simulation software users.
- Further developed Web-based "wizards" to perform accurate building analysis.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

HOT2000 is an official mark of Natural Resources Canada.

HOT3000 is a Trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

Community Energy Systems: Community Energy Systems Program

Objective: To increase the sustainability of Canadian communities by addressing their energy needs.

This program works in partnership with Canadian communities and businesses to address energy needs through a holistic approach to energy efficiency, renewable energy and community energy planning. NRCan has supported many district energy projects (some of which are based on renewable energy such as using waste energy from the local power plants) in Ontario, Prince Edward Island, the Northwest Territories, Nunavut and Yukon. NRCan continues to help communities to develop Sustainable Community Energy Plans, using tools that are designed to reduce energy demand, emphasize conservation and promote reliance on local renewable energy sources.

Key 2003–2004 Achievements

- Continued the community energy training program and held workshops in Springhill and Port Hawkesbury, Nova Scotia, and in Pembroke, Ontario.
- Developed a planning methodology that enables municipalities to develop a long-term growth strategy while minimizing energy consumption and maximizing renewable energy.
- Sponsored the Canadian District Energy Association Conference and the Federation of Canadian Municipalities' study tour to Europe.
- Supported a field trial of a high-efficiency, 60-kilowatt microturbine installation supplying heat and power to Place des Arts, Montréal. This project was also funded by Hydro-Québec and Gaz Métro, and the packaged heat recovery turbine system was supplied by Mariah Energy Corporation of Calgary.
- Carried out a study of the properties of a Drag Reducing Agent that is capable of reducing by approximately 80 percent pumping costs in buildings or district heating systems. Constructed a test rig to mimic a district heating system in tests of building energy transfer stations.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_ces_e.html

Chapter 6: Industry

Energy Use and Greenhouse Gas Emissions

The industrial sector includes all manufacturing industries, all mining activities, forestry and construction; however, it excludes electricity generation. This sector uses energy in industrial processes as a source of motive power to produce heat or to generate steam. Overall, industrial energy demand accounts for 38.7 percent (3176 petajoules) of secondary energy use and 33.8 percent (163 megatonnes) of greenhouse gas (GHG) emissions (including electricity-related emissions).

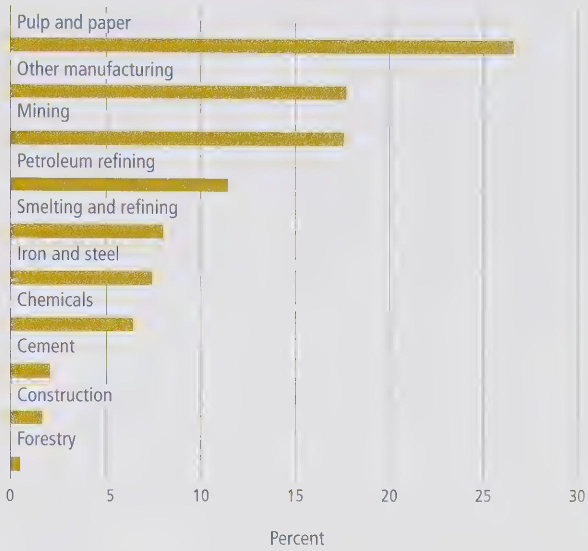
Within the industrial sector, energy is consumed primarily in pulp and paper, mining, petroleum refining, and smelting and refining industries. Pulp and paper alone accounted for almost 27 percent of total industrial energy demand in 2002 (see Figure 6-1).

In most industries, energy purchases account for only a small proportion of total expenditures. However, for some relatively energy-intensive industries – cement, chemicals, and pulp and paper – this share is higher than 14 percent (see Figure 6-2). For cement, in particular, the share is as high as 39 percent.

Actual industrial energy use increased by 16.9 percent (459 petajoules) between 1990 and 2002. This increase was driven by a 43.5 percent increase in industrial activity, measured as a combination of physical units of production, gross output and gross domestic product (GDP). However, some of this increase in energy use that would have resulted from the increase in activity was offset by improvements in energy efficiency and structural change – the shift to less energy-intensive industries (such as electrical and electronics).

FIGURE 6-1

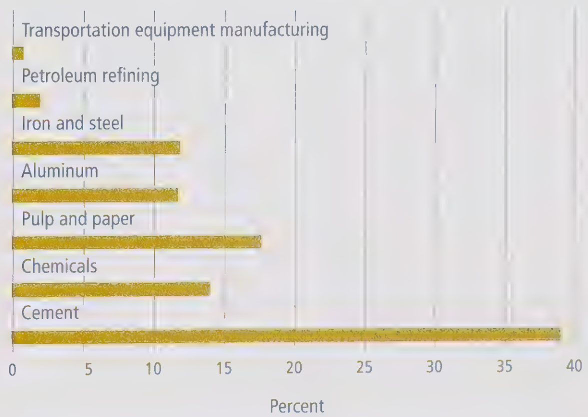
Industrial Energy Use by Sub-sector*, 2002



* Note: The above sub-sectors reflect the current definitions in the *Report on Energy Supply-Demand in Canada*. "Other manufacturing" comprises more than 20 manufacturing industries.

FIGURE 6-2

Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2002



Three main factors influenced energy use:

- activity – increases in physical units of production, gross output and GDP contributed to a 43.5 percent increase in industrial activity resulting in a 1183-petajoule increase in energy use
- structure – the change in the mix of activity toward less energy-intensive industries resulted in a 338-petajoule decrease in energy use
- energy efficiency – due to a 14.2 percent improvement in energy efficiency (between 1990 and 2002), the industrial sector avoided 386 petajoules of energy use in 2002 alone

The change in energy use between 1990 and 2002 and the estimated energy savings due to energy efficiency are shown in Figure 6-3.

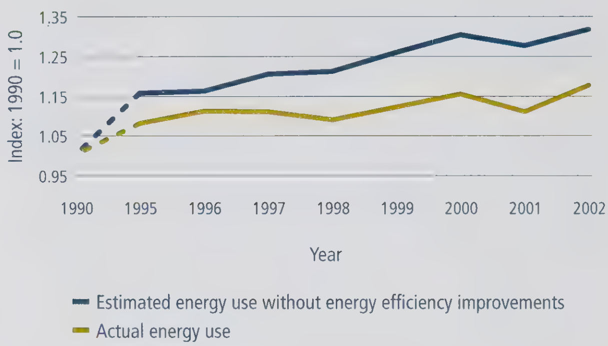
Between 1990 and 2002, industrial GHG emissions including electricity-related emissions increased by 15.2 percent. Excluding electricity-related emissions, industrial GHG emissions increased by only 8.2 percent over the same period. Most of this increase occurred in the upstream mining industry, while mining (excluding upstream), manufacturing and construction industries realized a 3.4 percent decrease in GHG emissions.

Natural Resources Canada (NRCan) delivers initiatives to increase energy efficiency in the following components of the industrial sector:

- industrial processes and technologies
- equipment
- buildings (refer to Chapter 5)

Figure 6-3

Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002



Industrial Processes and Technologies: Industrial Energy Efficiency

(Canadian Industry Program for Energy Conservation [CIPEC] and Industrial Energy Innovators [IEI])

Objective: To help Canadian industry use energy efficiency investments to improve competitiveness and to contribute to Canada's climate change goals.

CIPEC is a unique industry-government partnership committed to promoting and encouraging energy efficiency improvements and reductions in GHG emissions through voluntary action across Canada's industrial sectors. CIPEC comprises 25 sector task forces that involve more than 45 trade associations.

CIPEC, a sector-level program, and IEI, a company-level program, both address barriers to planning, implementing, tracking and reporting energy efficiency projects in industry. Key elements include the establishment and tracking of energy efficiency improvement targets and plans, and the development of products and services that overcome barriers to continued energy efficiency improvements. NRCan provides support via employee awareness kits and events, best-practices guides, technical information, energy audits, benchmarking and workshops on energy management.

CIPEC targets all of industry, including mining, manufacturing and construction as well as upstream oil and gas and electricity generation. Between 1990 and 2002, CIPEC mining, manufacturing and construction industries achieved an average energy-intensity improvement of 1.9 percent per year, thereby avoiding 23.8 megatonnes in GHG emissions. During this same time period, all CIPEC industries (including oil and gas and electricity generation) achieved an average energy-intensity improvement of 0.7 percent per year, thereby avoiding 25.2 megatonnes of GHG emissions. Effective energy management by CIPEC companies resulted in $3.4 billion in savings in 2002. As Figure 6-4 demonstrates, significant energy intensity improvements occurred in the latter part of the last decade. Between 1996 and 2002, energy intensity decreased by 11.0 percent.

FIGURE 6-4

CIPEC Energy Intensity Index, 1990–2002

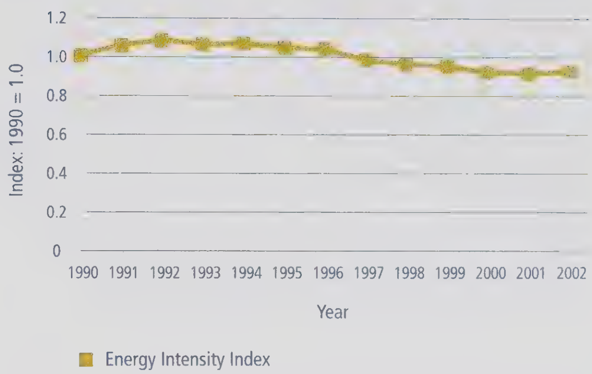
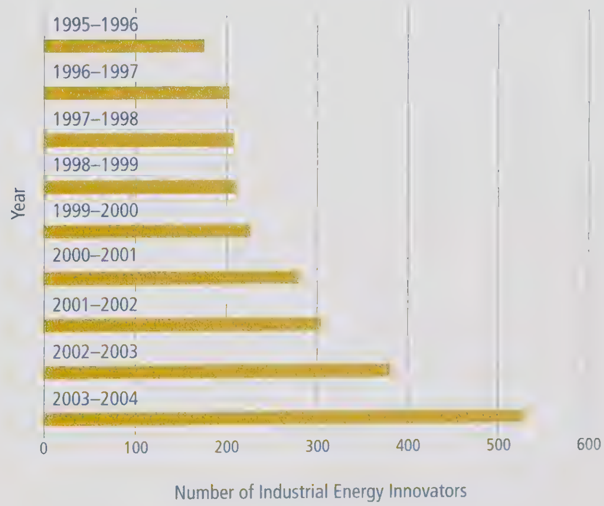


FIGURE 6-5

Industrial Energy Innovators, 1995–1996 to 2003–2004



According to a recent study, there is a statistically significant difference between energy consumed by CIPEC participants and non-participants:

- Growth of energy consumption for CIPEC participants was approximately half of that of non-participants (2.2 percent growth versus 5.4 percent growth).
- Three times more participants reported reduced energy use than non-participants.
- Fifteen percent fewer participants reported an increase in energy use than non-participants.

Key 2003–2004 Achievements

- Recruited 147 new Industrial Energy Innovators (see Figure 6-5).
- Initiated 152 Industrial Energy Audits.
- A study completed in May 2003 found that industrial companies that have participated in Dollars to $ense workshops have together saved more than 3 petajoules of energy and 184 kilotonnes of carbon dioixde (CO_2) equivalent per year.

For more information:
oee.nrcan.gc.ca/cipec/ieep

Industrial Processes and Technologies: Cleaner Fossil Fuel Power Generation

Objective: To design, develop and deploy technologies for power generation from fossil fuels with increased efficiency, and reduction and ultimately elimination of emissions of acid rain precursors, GHGs, particulates and identified priority substances – mercury, trace elements and organic compounds.

Research focuses on improving performance and reducing emissions for existing fossil fuel power plants and on developing new advanced cycles for conversion of fossil fuels to electricity with complete or near complete capture and elimination of CO_2 and other emissions. Additional research undertaken includes issues associated with the transport and storage of CO_2.

Key 2003–2004 Achievements

- Developed Canadian technology roadmaps that identify technologies that will be needed for the clean and efficient use of coal with CO_2 capture and storage – to be published in 2005.
- The Canadian Clean Power Coalition completed its evaluation of clean coal technology options for new power plant construction and is proceeding with plans to build a new clean coal technology power plant meeting near zero emissions into the atmosphere by 2010.
- Commissioned a new pressurized gasifier pilot plant capable of operating at 1400°C. The unit, the only one of its type in North America, will act as an economical testbed for Canadian utilities interested in advanced technology development, hydrogen production and CO_2 capture. Gasification provides high electricity generation efficiency; allows CO_2 capture at low cost and low energy penalty; permits economical, highly efficient removal of sulphur oxide, nitrogen oxide and mercury; and will provide energy security through clean use of Canada's indigenous coal reserves.
- Designed, manufactured, tested and patented a 100-megawatt equivalent oxy-fired gas turbine. The technology enables CO_2 and mercury capture through O_2/CO_2 combustion.
- Implemented with Canadian International Development Agency (CIDA), Canada Climate Change Development Fund, the Chinese government and private sector partners, a $3.1-million research and technology transfer project for power generation in China that will result in GHG reductions of up to 3.5 million tonnes over 10 years.
- Devised a new combustion protocol for assessing energy and emission performance of bitumen/water emulsions for industrial applications. This emulsified fuel can replace natural gas in the steam-assisted gravity drainage recovery of oil sand bitumen.
- Developed and tested, in cooperation with Ontario Power Generation, a low-cost sorbent injection, mercury capture technology for coal-fired electric utility boilers.
- Successfully demonstrated a new measurement and characterization methodology for $PM_{2.5}$ fine particulate matter emissions. Application of Canada-wide standards to large industrial sources in 2010 will require reliable measurement methods.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_e.html

Industrial Processes and Technologies: Processing and Environmental Catalysis Program

Objective: To solve industrial process problems and undertake research in areas with high potential for significant environmental and economic benefits

The program's facilities, including semi-pilot scale plants, are used for process testing and the evaluation of novel concepts in chemical and energy conversion, including hydrogen production from hydrocarbon and renewable sources. Clients include oil and gas companies, petrochemical companies, original engine manufacturers, waste oil renderers and specialty ceramic manufacturers.

Key 2003–2004 Achievements

- Developed a process for stabilizing/conditioning a diesel fuel derived from waste motor oil. CANMET Energy and Technology Centre (CETC) received its first royalty payment from licensing the process to a Malaysian company. A commercial plant was commissioned in December 2004.
- Developed ceramic membranes for hydrogen separation at high temperatures. This is an enabling technology to improve energy efficiency and economics of hydrogen production and hydrogen recovery in the petroleum/petrochemical industries. Reproducibility of membranes is now approaching 100 percent.
- Developed zero emissions ammonia fuel cells in collaboration with CANMET Materials Technology Laboratory. Proof of concept has been demonstrated, resulting in two peer-reviewed journal publications. Preliminary assessment indicates a significant market opportunity exists for 10–20 kilowatt fuel cells in distributed power generation. Two ammonia producers have expressed interest in this technology.
- Developed a technology for the production of low-sulphur, high-cetane blending stock from waste restaurant grease and vegetable oils. Life-cycle analysis shows a 23 percent reduction in GHG emissions using a 20 percent blend of tallow-derived SuperCetane and diesel fuel. A 20-litre production run was done for the Government of Ontario using soy oil as a feedstock.
- Developed a highly energy-efficient process for converting naphtha to olefins. Catalyst testing was done for Valeo Management Services, a technology development company spun off from Concordia University.
- Developed pyroelectric generation technology. This technology produces electricity from low-grade waste heat for increased industrial plant efficiency, and it avoids GHG emissions due to combustion of fossil fuels to provide part of or all of the power requirements of an industrial plant. The power density of lab-scale prototype units has reached 300 watts per litre of active material.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_pec_e.html

Industrial Processes and Technologies: Industrial System Optimization Program

Objective: To support the development and adoption of innovative energy-efficient practices in Canadian industry to continuously improve its energy efficiency and productivity, while decreasing GHG emissions and other environmental impacts.

The program focuses on systematic industrial process analysis methods and techniques, such as Process Integration (PI) and advanced process control systems, to identify and correct inefficiencies in plant operation taking into account energy, economy and environmental aspects. It seeks to meet its objective by performing leveraged research and development through national and international collaboration. Furthermore, the program disseminates technical information that will encourage the adoption of these practices in targeted energy-intensive sectors of Canadian industry including pulp and paper, oil upgrading and refining, petrochemicals, steel, chemicals, solid wood, and food and drink.

Key 2003–2004 Achievements

- Completed a successful collaboration in PI with Cascades Inc., a North American leader in the production, conversion and marketing of packaging products; this collaboration entailed training engineers and the completion of two PI studies. This initiative allowed Cascades to identify cost-effective energy savings of $4.5 million per year, with an average payback period of eight months, and GHG emission reductions of 34 kilotonnes per year.
- Disseminated information on the value of PI by participating in a series of six technical workshops with representatives of energy-intensive Canadian industries, and through a unique and high quality Web site.
- Conducted a survey on energy performance of sawmills in the province of Quebec that showed that there is room for significant energy savings. Furthermore, decision-making tools were developed for better process operation and energy management in sawmills using a data mining approach.

For more information:
cetc-varennes.nrcan.gc.ca/en/indus.html

Industrial Processes and Technologies: Industry Energy Research and Development (IERD) Program

Objective: To encourage and support the development and application of leading-edge, energy-efficient and environmentally responsible processes, products, systems and equipment in industry.

Financial support is provided for commercially confidential applied research and development (R&D) activities, which is repayable if the project is commercially successful. Program clients from all industrial sectors range from small- and medium-sized companies to multinational corporations.

Key 2003–2004 Achievements

- Further to the successful completion of an IERD-supported R&D project, Turbocor Inc. of Montréal, Quebec, is commercializing a novel compressor for refrigeration applications that requires no lubricating oils and has no chlorofluorocarbons. This represents a breakthrough in industrial and commercial refrigeration and is generating energy savings of 30 percent. Turbocor won a Canada's Energy Efficiency Award in early 2003, the 2003 Air-Conditioning, Heating and Refrigeration Expo's "Energy Innovation" Award and most recently the 2004 U.S. *Environmental Protection Act* Climate Protection Award, which is given to organizations for the extraordinary accomplishments that have made significant contributions to protecting the environment.
- Société des technologies de l'aluminium du Saguenay in Chicoutimi, Quebec, is working at developing, in partnership with Lauralco Inc. in Deschambault, Quebec, an automated anode replacement and positioning system. This system will increase energy efficiency of the aluminum smelting process and reduce GHG emissions. This system is forecast to be in service by end of 2004.
- Systèmes d'Optimisation Énergétiques Inc., Saint-Mathieu-de-Beloeil, Quebec, is a young company that is developing a new mechanical transmission for diesel generator sets. The projected energy savings is in the 15 to 25 percent range. This new device will also permit extension of the diesel engine life by 25 percent.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/factsheet_industry_energy_research_and_development_program_e.html

Industrial Processes and Technologies: Emerging Technologies Program (ETP)

Objective: To support the identification and demonstration of new and emerging energy-efficient technologies.

Projects are co-managed and cost-shared with industry and other stakeholders, such as gas and electric utilities, other governments and equipment manufacturers. Financial support is provided for the development and testing of pilot plants, prototypes and full-scale field trials to evaluate operating performance, energy efficiency and environmental impacts. NRCan's financial support is repayable from any cost savings or revenues realized from a project.

Key 2003–2004 Achievements

- NRCan is supporting Sirex Engineering of Mississauga, Ontario, in its development of a production-scale process that recycles post-industrial polyethylene cross-linked foam waste material into foam sheet products. Pressure on landfill sites will be alleviated and substantial energy reduction will be achieved by supplanting or replacing a new stream of polyethylene foam and the depletion of petrochemical feedstocks.
- Westport Research Inc. of Vancouver, British Columbia, with NRCan support, has delivered and installed a natural gas engine for stationary power generation to a water/wastewater treatment facility in Grande Prairie, Alberta, and by September 2004 will complete a one-year field trial of a low-emissions (17.8 percent less CO_2) natural gas engine for stationary power generation using the Westport high-pressure direct injection technology.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/funding_programs_etp_e.html

Industrial Processes and Technologies: Industrial Energy Innovation

Objective: To assist major industrial energy consumers to reduce the energy intensity of their operations and to reduce GHG emissions, by-product emissions of CO_2 and other GHGs.

Industrial combustion processes are the major sources of industrial GHG emissions. Because they operate at low thermal efficiencies of 30 to 50 percent, there are major opportunities to improve industrial energy efficiency and productivity while significantly reducing GHG emissions.

CETC's work in this area includes changing the interaction of the combustion system with the process, with advanced tools and technologies. As well, together with the Large Final Emitters Group and the Office of Energy Efficiency, CETC held technical workshops with major industry sectors (steel, mining, smelting and refining, cement, lime, and pulp and paper) and with CIPEC, industrial associations and individual companies to help define and map partnerships for a generic industrial combustion R&D program and applications to take advantage of these opportunities, with potential energy and GHG reductions of 10 to 40 percent. In addition, it is engaged in developing generic tools and technologies that cross industry sectors, fuels and furnaces.

Key 2003–2004 Achievements

Numerous projects contributed the following:

- greater energy efficiency in the making of iron and steel
- higher energy efficiency and reduced GHG emissions in coking processes used in the iron and steel industry
- development of high-efficiency, low-nitrogen-oxide burners for industry
- application of low-cost computational fluid dynamic (CFD) modelling as a pre-cursor to large engineering projects to inject natural gas into blast furnaces and upgrade a refinery heater
- improved performance and reduced emissions in flaring emissions in refining and chemical industries through flare tip redesign and a software tool to assess oil field emissions
- test facility for combustion performance of bio-oil in micro-turbine and other combustors
- developed scanner technology that monitors burner performance and optimizes operation for industrial applications

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_e.html

Industrial Processes and Technologies: Minerals and Metals Program

Objective: To reduce GHG emissions from Canada's Minerals and Metals Sector by enhancing mineral and metal recycling processes and practices, and by assessing alternate production processes. The initiative has a GHG reduction target of at least 1.65 million tonnes of CO_2 equivalent per year, by 2010.

The Minerals and Metals Program is a component of the *Government of Canada Action Plan 2000 on Climate Change*. The Minerals and Metals Program was restructured in 2003–2004 to allocate $10 million to two distinct areas: Enhanced Emission Reduction for Minerals and Metals, and Enhanced Recycling. The Program is managed by a Steering Committee consisting of representatives from Environment Canada, Industry Canada and Natural Resources Canada (Chair) and two program-area-specific Advisory Committees, consisting of experts in the field and representatives from industry, government and non-governmental organizations. Daily operations are overseen by the CANMET Mineral Technology Branch. The Enhanced Emission Reduction for Minerals and Metals program area supports activities that will increase the use of fly ash, blast-furnace slag, silica fume and other Supplementary Cementing Materials (SCMs) in concrete to displace Portland cement, thereby reducing the GHG intensity of concrete production. The Enhanced Recycling program area aims to increase Canada's potential to recycle all materials by developing new approaches and improving upon existing recycling infrastructure, practices and policies.

Key 2003–2004 Achievements

- EcoSmart™ Foundation Inc. received funding for several technical studies and a national expansion to broaden the impact of its work.
- CANMET's Materials Technology Laboratory began development of a user-friendly tool for contractors wanting to use SCMs in their construction projects. The program also supports a broad range of initiatives such as examining cogeneration and CO_2 sequestration.
- The Enhanced Recycling program raised awareness of many important issues among a broad group of stakeholders across Canada, especially at the municipal and regional level, through participation in various communications opportunities. Other activities included completion of a scan of metals and minerals recycling programs to determine effectiveness and ongoing improvements in statistics/data collection for secondary resources in order to identify gaps in current recovery strategies.

For more information:
nrcan.gc.ca/mms/canmet-mtb/mtl/research/concrete_e.htm

Equipment: Energy Efficiency Standards and Regulations

Objective: To eliminate the less energy-efficient models of energy-using equipment from the market through minimum performance regulations under the *Energy Efficiency Act*.

The *Energy Efficiency Regulations* incorporate national consensus performance standards that include testing procedures to determine the energy performance of the equipment. They prohibit the import of, or interprovincial trade in, prescribed products that fail to meet minimum energy performance levels and labelling requirements.

Key 2003–2004 Achievements

- Pre-published eighth amendment to the *Energy Efficiency Regulations* to increase the minimum energy-performance standards for clothes washers and gas-fired and electric storage water heaters, and to establish minimum energy-performance standards for water chillers and exit signs.
- The cumulative annual reductions in CO_2 emissions resulting from the aggregate energy savings attributable to the eighth amendment to the *Energy Efficiency Regulations* are estimated to be approximately 0.19 megatonnes in the year 2005 and 3.61 megatonnes in the year 2020.

For more information:
oee.nrcan.gc.ca/regulations/home_page.cfm

Equipment: Labelling and Promotion

Objective: To promote the production, purchase and use of more energy-efficient equipment.

The initiative consists of EnerGuide for Equipment, which provides comparative information on the energy performance of equipment – including heating, ventilating and air conditioning (HVAC) – and the ENERGY STAR® label, which allows industrial purchasers to identify the most energy-efficient products available based on a standard set of criteria.

Key 2003–2004 Achievements

- Market studies completed for compressors, uninterruptible power supplies, battery chargers, arc welding and pumps.

For more information:
energuide.nrcan.gc.ca
oee.nrcan.gc.ca/equipment
energystar.gc.ca

Equipment: Mine Ventilation

Objective: To reduce energy consumption and GHG emissions associated with mine ventilation through infrastructure automation (to support demand-based delivery systems), ventilation network optimization and management, and less air-volume demanding technology.

Mine ventilation systems that were traditionally designed to operate at maximum flow (peak production 24 hours a day and 7 days a week) are being adjusted to match actual production needs. Ventilation is required in underground mines to maintain a safe working environment by diluting and removing harmful pollutants (dusts and gases) and providing a thermally suitable working climate. Providing sufficient and suitable ventilation can account for 40 percent of the energy consumed underground by a mining operation. Efficient energy savings at less than peak demands range from linear for the heating/cooling systems to a cubic relationship for the primary fan system. However, optimizing energy use is not straightforward, as it depends on the specific consumption profile for each mine and therefore needs evaluation on a case-by-case basis.

Key 2003–2004 Achievements

- A "ventilation on demand" feasibility study continued for a deep-ore zone with INCO Limited's Creighton Mine. The focus was to reduce the energy demands of the existing ventilation system, delay any need for mechanical refrigeration and identify, track or control the production requirements to achieve these savings.
- A ventilation benefit analysis was completed on the potential impact of converting from diesel to fuel-cell powered production equipment. This study showed that ventilation could be reduced but other contaminants became the limiting design criteria, and the reductions in energy, GHG emissions and cost were very dependent on factors such as the mine's energy consumption profile.
- There was a collaborative development (funded by the Office of Energy Efficiency) of a mine life-cycle ventilation demand simulator. This initial simulator, which is part of an NRCan engineer's ongoing doctoral thesis, will determine where the optimal energy environment and cost benefits in mine ventilation networks exist.

For more information:
nrcan.gc.ca/mms/canmet-mtb/mmsl-lmsm/mines/air/air-e.htm

Chapter 7: Transportation

Energy Use and Greenhouse Gas Emissions

The transportation sector consists of three sub-sectors: passenger, freight and off-road. Passenger and freight transportation accounted for 56.7 percent and 39.3 percent, respectively, of transportation energy use, with off-road representing only 4.0 percent in 2002. The passenger sub-sector is composed of three modes: road, rail and air. The freight sub-sector, as defined by Natural Resources Canada (NRCan), is composed of road, rail, air and marine. Road transport uses the most energy, accounting for 78.1 percent of total transportation energy use in 2002. Of this amount, 60.5 percent was passenger energy use and 39.5 percent was freight energy use (see Figure 7-1).

All NRCan transportation energy-use programs focus on the energy used in road transportation. Total transportation energy use increased by 22.8 percent (428 petajoules) over 1990 to 2002 (see Figure 7-2). Passenger transportation energy use increased by 13.0 percent (150 petajoules), while freight transportation energy use increased by 36.0 percent (240 petajoules).

Three main factors influenced energy use:

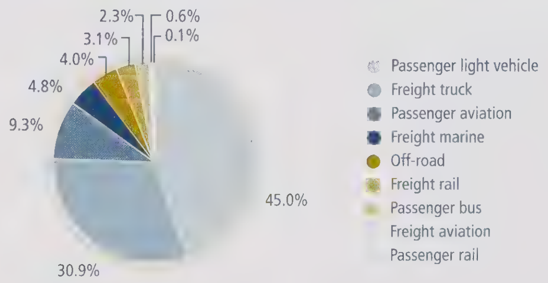
- activity – due to increases in population and economic activity, there was greater transportation activity (measured as passenger-kilometres for passenger transportation and tonne-kilometres [tkm] for freight transportation). This increased transportation energy use by 23.1 percent (412 petajoules). The freight and passenger segments contributed to this increase by 57.7 percent and 42.3 percent, respectively.
- structure – shifts between modes of transport were significant in passenger (sharp increase in the stock of light trucks) and freight (freight trucks are growing significantly faster than rail and marine) segments, resulting in an increase of 9.3 percent in transportation energy use (165 petajoules).
- energy efficiency – improvements in energy efficiency worked to decrease energy use by 9.9 percent (178 petajoules).

Without improvements in energy efficiency, increases attributable to activity and structure would have led to an increase in transportation energy use of 32.4 percent (577 petajoules). However, as a result of improvements in energy efficiency, actual energy use increased by 22.8 percent. This change in energy use between 1990 and 2002, as well as the estimated energy savings due to energy efficiency, is shown in Figure 7-2.

The transportation sector accounts for 28.1 percent (2306 petajoules) of secondary energy use and 34.2 percent (165 megatonnes) of greenhouse gas (GHG) emissions. From 1990 to 2002, transportation energy use increased by 22.8 percent, and GHG emissions increased by 22.1 percent. The change in GHG intensity of transportation energy use was negligible.

FIGURE 7-1

Transportation Energy Use by Mode, 2002



* Totals do not add due to rounding

Figure 7-2

Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002

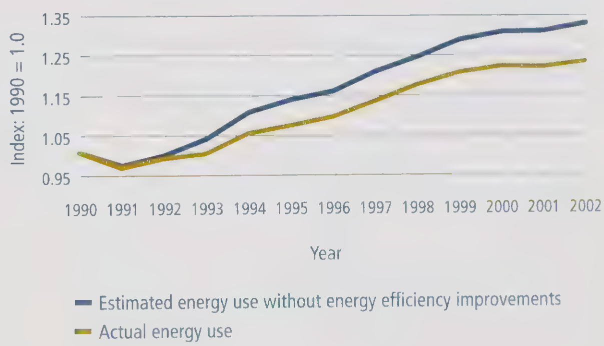


FIGURE 7-3

Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2002

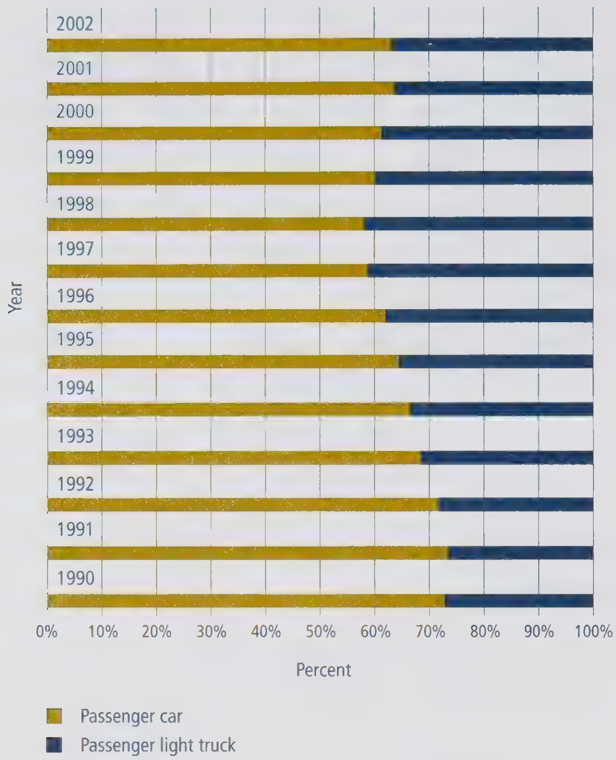


Figure 7-3 shows how the market share of new light trucks increased in the 1990s, reflecting the growth in popularity of minivans and sport-utility vehicles. Figure 7-4 demonstrates that, on a per-kilogram or per-unit-of-horsepower basis, fuel efficiency has improved markedly. However, average fuel economy has been stable because new vehicles continue to be heavier and have more powerful engines.

Figure 7-5 illustrates an improvement in trucking energy intensity despite an increase in average activity over 1990 to 2002. Improved fleet practices, caused by an increase in the competitiveness of the transportation sector and by the introduction of electronic engines, have significantly improved engine fuel efficiency in medium-duty and heavy-duty trucks.

NRCan delivers initiatives in the following areas to increase the efficiency of motor vehicles and encourage the use of alternative fuels:

- vehicles
- transportation research and development
- alternative transportation fuels
- transportation technologies

Figure 7-4

New Car Fuel Efficiency, Normalized for Weight and Power, 1990 to 2001

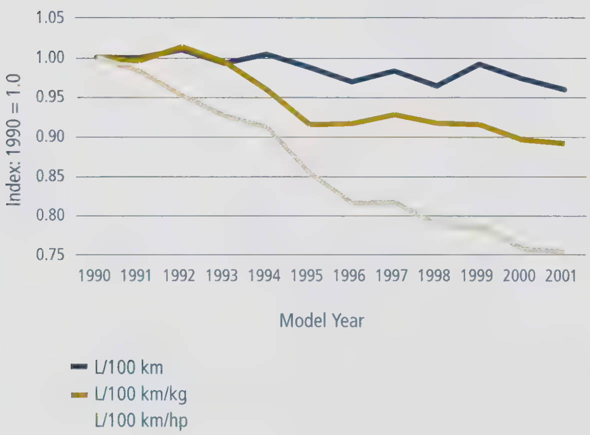
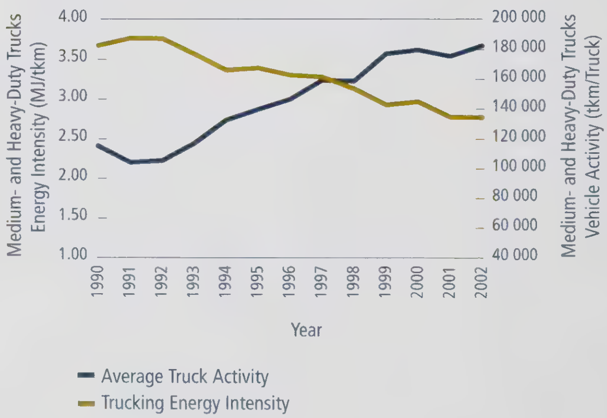


Figure 7-5

Changes in Trucking Energy Intensity and Average Activity per Truck, 1990–2002



Vehicles: Vehicle Efficiency

Objective: To improve the fuel efficiency of new light-duty vehicles sold in Canada.

The Motor Vehicle Fuel Efficiency Initiative is intended to bring about a 25 percent improvement in the fuel efficiency of new light-duty vehicles sold in Canada by 2010. NRCan is leading negotiations with the automotive industry to reach agreement on a voluntary fuel efficiency target for new vehicles. GHG reductions of 5.2 megatonnes in 2010 are being sought.

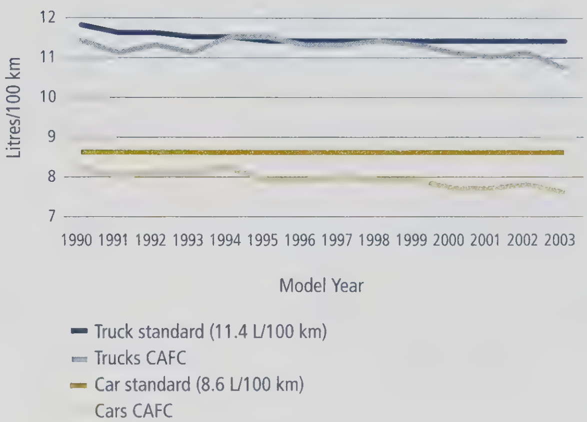
Key 2003–2004 Achievements

- Completed a joint study between NRCan and U.S. Department of Energy on the future potential of hybrid and diesel powertrains in the North American light-duty vehicle market.
- Completed round of discussions with auto industry regarding fuel efficiency targets.

For more information:
oee.nrcan.gc.ca/english/programs/motorvehicles.cfm

Figure 7-6

Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards, 1990 to 2003



Vehicles: Personal Vehicles

Objective: To improve motor vehicle fuel efficiency by encouraging private motorists to develop energy-efficient vehicle purchase, use and maintenance practices.

The Personal Vehicle information program promotes improving vehicle fuel efficiency in order to reduce vehicle emissions and mitigate other vehicle-related environmental impacts. The program helps motorists understand how automobile purchases and driving and maintenance habits affect climate change and the environment. It encourages Canadians to purchase the most fuel-efficient vehicle that meets their everyday needs and to adopt fuel-efficient driving techniques and maintenance practices.

Key components include the EnerGuide fuel-consumption label for vehicles and the annual *Fuel Consumption Guide*, which provide fuel consumption data for new light-duty vehicles; the Idle-Free Campaign, which seeks to curb vehicle idling; and the Auto$mart Driver Education Kit, which helps driving instructors teach fuel-efficient driving to novice drivers. Recently the initiative developed a national public awareness and education campaign, in collaboration with the tire manufacturing industry, to encourage Canadian motorists to adopt good tire maintenance and inflation practices.

Key 2003–2004 Achievements

- Successfully completed the Idle-Free Campaign in Calgary, Edmonton, the Greater Toronto Area, Caledon, Ottawa, Sherbrooke and Québec City.
- Tire inflation campaign developed and launched.
- Recruited one new manufacturer for the EnerGuide label for vehicles.

For more information:
oee.nrcan.gc.ca/vehicles

FIGURE 7-7

Vehicle Fuel Efficiency Awareness – EnerGuide Labels

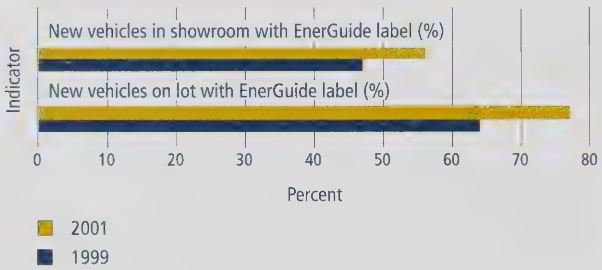


FIGURE 7-8

Vehicle Fuel Efficiency Awareness – Auto$mart

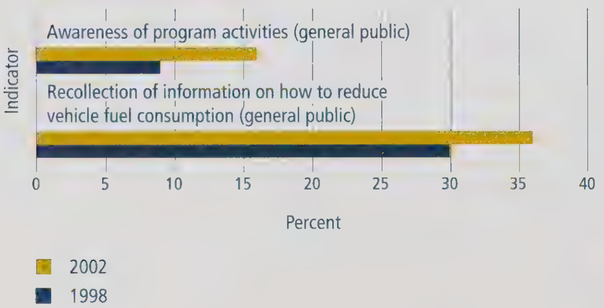


FIGURE 7-9

Number of New Drivers Educated Using the Auto$mart Student Driving Kit, 1997–1998 to 2003–2004

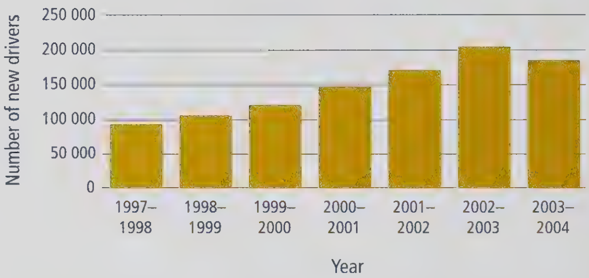


FIGURE 7-10

EnerGuide Label for New Vehicles

Vehicles: Fleet Vehicles

Objective: To improve motor vehicle fuel efficiency by encouraging private motorists to develop energy-efficient vehicle purchase, use and maintenance practices.

Fleet Vehicles provides information materials, workshops, technical demonstrations, driver training programs and special projects, such as the Truck Stop Idle-Free Quiet Zone Campaign, to help fleet operators assess and pursue opportunities to increase energy efficiency in their operations. To increase market penetration of fuel-efficient and emission-reduction technologies, the Fleet Vehicles initiative also provides financial incentives to commercial fleets purchasing pre-selected anti-idling technologies and Natural Gas Vehicle technologies. NRCan delivers the Fleet Vehicles initiative in partnership with fleets, industry stakeholders and other levels of government.

Key 2003–2004 Achievements

- The SmartDriver workshops trained more than 160 000 new and experienced drivers and introduced over 700 new instructors to the SmartDriver materials.
- Three anti-idling technologies have been certified under the Commercial Transportation Energy Efficiency Rebate (CTEER) initiative.
- Provided over $850,000 in incentives through the CTEER initiative

For more information:
fleetsmart.nrcan.gc.ca

FIGURE 7-11

Drivers Trained and Participation in the Fleet Vehicle Program, 1997 to 2004

Transportation Research and Development: Canadian Lightweight Materials Research Initiative (CliMRI)

Objective: To develop low-density, high-strength, lightweight materials to achieve weight reductions in ground transportation vehicles.

CLiMRI is a research network comprising twenty-nine companies, eight universities and seven government departments and funding agencies. CLiMRI's goal is to develop and implement lightweight and high-strength materials in transportation applications for the purposes of (a) reducing GHG emissions through vehicle weight reduction and improving vehicle efficiency, and (b) improving the competitive performance of Canadian primary metals producers, automotive part manufacturers and suppliers.

Key 2003–2004 Achievements

- Magnesium is one of the lightest of all metals, but its use in automotive applications is currently limited to die-cast parts because of difficulties in producing magnesium in sheet form. CANMET Materials Technology Laboratory (CANMET-MTL) has developed a moving plate to simulate the twin-roll strip casting of magnesium sheets, and the material's performance is being assessed. This achievement shows significant potential for increasing the use of magnesium in the automotive industry.
- Unlike aluminum, magnesium is prone to corrosion in the presence of chlorides such as road de-icing salt. Corrosion control is therefore a key enabling technology that will lead to wider-scale application of magnesium in automobiles. As part of a large program with the U.S. Department of Energy and car makers, CANMET-MTL is leading the corrosion control and coating assessment research for magnesium alloys. Environmentally friendly coatings have been selected, and a new candidate material developed for use as spacers and washers. The team also contributed to the redesign of a magnesium engine cradle for General Motors Corporation's Corvette.
- Recent developments in hydroforming, a metal-shaping process that uses gas or water at high pressures to form tubes or sheet metal, have enabled significant productivity gains and weight reductions for complex structural components in the automotive industry. In the last year, CANMET-MTL fabricated aluminum and high-strength steel tubes and optimized welding parameters. Testing trials confirmed the validity of laboratory tests for predicting the integrity of aluminum hydro-formed seam-welded tubes.

For more information:
climri.nrcan.gc.ca/default_e.htm

Transportation Research and Development: Fuel-Cell-Powered Mining Vehicles

Objective: To develop the technology to replace diesel power by hydrogen fuel cell power in underground mining vehicles.

NRCan has taken a co-leadership role in the North American Consortium for Fuel-Cell-Powered Mining Vehicles. Hydrogen fuel cell power systems are twice as efficient in delivering power as conventional diesel equipment. Retrofitting diesel-powered vehicles with hydrogen fuel cells improves vehicle productivity, operating costs and the work environment for underground miners by eliminating toxic underground diesel emissions and by reducing heat and noise. Fuel cells have also been shown to have the potential to significantly reduce carbon dioxide (CO_2) or GHG emissions by up to one million tonnes per year (26 percent of the total CO_2 emitted by the mining extraction sector) and decrease operating costs by lowering mine ventilation needs by 20 to 40 percent, depending on the mine.

Key 2003–2004 Achievements

- The fuel cell locomotive is now at the experimental mine in Val-d'Or, Quebec, undergoing long-term reliability testing of the fuel cell power plant. Tests are being carried out to quantify power delivery, hydrogen consumption, risk quantification and refuelling aspects.
- Assembled partners and initiated the fuel cell underground mine loader project (the main production vehicle). The loader power plant has been designed and full vehicle testing will start in 2005.
- Initiated a light-duty mining vehicle project, representing the most polluting of underground diesel mining vehicles. It will be the focus of an all-Canadian partnership for commercialization initiative.
- Addressed mine regulatory issues in several new projects and partnership discussions to have fuel cells in operation in underground Canadian mines.
- Continued technology transfer made through a special session of the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) 2003 Annual General Meeting, two publications in the CIM Bulletin, one article in the Journal of Power Sciences, and an article in the 2003 Canadian Computer Application to the Mineral Industry Conference proceedings.

For more information:
nrcan.gc.ca/mms/canmet-mtb/mmsl-lmsm/mines/mines-e.htm

Alternative Transportation Fuels: Future Fuels Initiative

Objective: To increase Canada's fuel ethanol production and use in the transportation sector.

The Future Fuels Initiative, co-managed with Agriculture and Agri-Food Canada, targets end-users of gasoline, provinces and territories, and existing and potential fuel ethanol producers. The Future Fuels Initiative aims to increase the supply and use of fuel ethanol produced from biomass such as plant fibre, corn, wheat and other grains. The main components of this initiative are public education and analysis of socio-economic and GHG emission impacts. Additionally, the Future Fuels Initiative includes the National Biomass Ethanol Program, administered by Farm Credit Canada, which aims to overcome lender resistance to investing in ethanol plants due to the uncertainty of future excise tax policy.

Key 2003–2004 Achievements

- Completed an ethanol-blended gasoline awareness campaign in fall 2003 in partnership with fuel retailers in Ontario and Quebec.
- Completed a national ethanol awareness survey: results show that 85 percent of Canadians are in favour of increased ethanol-blended gasoline use in Canada (Ipsos-Reid, March 2004).
- Extended GHG emission and energy use modelling capabilities.

For more information:
www.vehiclefuels.gc.ca

Alternative Transportation Fuels: Ethanol Expansion Program

Objective: To expand fuel ethanol production and use in Canada.

The Ethanol Expansion Program, co-managed with Agriculture and Agri-Food Canada, targets existing and potential fuel ethanol producers. The program provides contributions to new or expanded fuel ethanol production facilities through a competitive solicitation process. Selection criteria are based on the ability to maximize ethanol production and use in Canada and the ability to reduce transportation GHG emissions. Additionally, the program is investigating the range of programs that could be used to develop a successful commercial cellulose-based ethanol industry in Canada (i.e. ethanol produced from agricultural residues or wood).

Key 2003–2004 Achievements

- Completed the proposal selection process for the first round of funding and allocated contributions to seven projects from across Canada that plan to increase domestic ethanol production by a total of 750 million litres per year.
- Engaged in extensive discussions with cellulosic ethanol industry proponents.

For more information:
www.vehiclefuels.gc.ca

Alternative Transportation Fuels: Biodiesel Initiative

Objective: To support increased biodiesel production and use in Canada's transportation sector.

The Biodiesel Initiative supports the Government of Canada's proposed target of 500 million litres of biodiesel production per year by 2010. The main components of this initiative are research and development, technical and socio-economic studies, end-use demonstrations and testing, stakeholder education and standards development.

Key 2003–2004 Achievements

- Commissioned long-haul commercial transport, marine and fleet vehicle end-use technology demonstration projects.
- A biofuels quality registry was established with the Alberta Research Council – a centre of excellence in this field – to set an industry protocol and standard for fuel analysis.
- Formation of an international cooperated effort to conduct a biosafety assessment on the use of animal fats in biodiesel.
- Ongoing technical and economic assessments of biodiesel production including feedstocks, production processes and use of the biofuel.

For more information:
vehiclefuels.gc.ca

Alternative Transportation Fuels: Canadian Transportation Fuel Cell Alliance

Objective: To demonstrate and evaluate different processes for the production and delivery of hydrogen to fuel cell vehicles at fuelling stations and to participate in the development of codes and standards.

The Canadian Transportation Fuel Cell Alliance (CTFCA) is a private-public sector initiative composed of technology developers, fuel providers, auto manufacturers, federal and provincial/territorial governments, academia and non-governmental organization representatives. The CTFCA's work contributes to a reduction in GHG emissions by encouraging advancements in hydrogen and fuel cell technologies through demonstration projects that evaluate the technical, economic and environmental feasibility of different hydrogen fuelling options for fuel cell vehicles. The initiative also establishes a supporting framework for hydrogen fuelling by assisting in the development of codes and standards as well as certification and training programs.

Key 2003–2004 Achievements

- Commissioned prototype fuelling station and upgraded operating fuelling stations.
- Ongoing codes and standards activities at a national and international level and produced draft hydrogen installation code for Canada.
- Assessment and evaluation of fuelling pathways is ongoing and several studies are underway or completed.

For more information:
nrcan.gc.ca/es/etb/ctfca/index.html

Alternative Transportation Fuels: Hydrogen Economy and Transportation Energy Program

Objective: In partnership with industry, to develop and deploy leading-edge hydrogen and transportation technologies that reduce GHG emissions, minimize other environmental impacts, increase the potential for job and economic growth and extend the life span of Canada's energy resource base.

Program staff work with stakeholders in the domestic and international hydrogen and transportation industries, including original equipment manufacturers, industry associations, fleet managers, transit authorities, utilities, provincial and territorial governments, research organizations, universities, other federal departments, the U.S. Department of Energy and the International Energy Agency.

Highlights of the Hydrogen Economy and Transportation Energy Program's work include:

- Supporting Canadian industry in developing a world-leading water electrolysis technology for the production of hydrogen from clean renewable energy sources.
- Working in partnership with Canada's fuel cell industry over the last 15 years, which has established Canada as a world leader in fuel cell and refuelling technologies; for example, the world's first hydrogen fuel cell bus was demonstrated in Canada.
- Supporting student vehicle challenges since the 1980s, and bringing university and college students from across North America together with automotive manufacturers to modify existing vehicles to run on a variety of alternative fuels. The program has also supported the development of alternative transportation fuel technologies, for example, for natural gas and propane vehicles, which has led to a Canadian industry that is now exporting commercial products.

Key 2003–2004 Achievements

- Organization and sponsorship of world-class conferences, including the 2003 Canadian Hydrogen and Fuel Cells Conference and Trade Show.
- Demonstration of a 10-kilowatt fuel cell power module, suitable for off-road mobility applications, in a vehicle.
- A 5000-psi (pounds per square inch) hydrogen storage cylinder was certified, and 300 of these cylinders were sold.
- Two companies licensed and commercializing natural gas engine control systems developed by the Saskatchewan Research Council.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_tet_e.html

Chapter 8: Renewable Energy

Renewable Energy Use

In 2002, renewable energy generation capacity from renewable sources accounted for 61 percent of total Canadian electricity capacity (see Table 8-2). Most of the renewable energy used in Canada comes from either hydro-electricity or thermal energy from biomass such as wood-waste sources.

Hydro-Electricity

Hydraulic power is a renewable energy based on the water cycle – evaporation, precipitation and flow of water toward the ocean. Canada has abundant water resources, and its geography provides many opportunities to produce low-cost energy. Tapping the energy from moving water has played an important role in the economic and social development of Canada for the past three centuries.

In 2003, hydro power accounted for about 60 percent of total electricity generation. Small-scale hydro-electric projects, with a capacity of 20 megawatts or less, constitute about 4 percent of Canada's electricity-generating capacity. Small-scale hydro has good potential for increased production.

Biomass

Bioenergy is a renewable source of energy derived from organic substances known as biomass. Biomass is supplied by agricultural wastes (such as chaff, straw, grain screenings, husks and shells, food-processing residues and methane) and forestry wastes (such as logging slash, sawdust, black liquour from the pulping process and other industrial waste). Other biomass supplies include animal litter and manure, landfill gas methane, urban wastes to be incinerated and sewage for biogas. Bioenergy contributes about 6 percent of Canada's primary energy, mostly for industrial process heat, electricity generation and residential space heating. Corn and other agricultural products are also used to generate ethanol and biodiesels for the transportation market.

TABLE 8-1

Renewable Energy Markets and Technologies Used in Canada

Electricity	*Thermal Energy*
Hydro-electricity	Biomass (e.g. roundwood, pellets, wood chips)
Tidal power	Ground-source heat pumps (e.g. earth energy)
Biomass (e.g. wood waste)	Solar air-heating systems
Biogas (e.g. methane from landfill sites)	Solar hot-water systems
Wind turbines	
Photovoltaic systems	
Mechanical Power	*Transportation*
Wind water pumps	Ethanol from biomass

TABLE 8-2

Electricity Generation Capacity From Renewable Sources (Includes Hydro)

Year	*Renewable electricity generation capacity (MW)*	*% of total capacity*
2002	71 527	61
2001	71 163	61
2000	68 986	62
1999	68 686	62
1998	68 340	62
1997	68 202	61
1996	67 101	59
1995	66 542	57
1994	63 175	56
1993	63 114	56
1992	62 895	58
1991	61 116	58
1990	59 557	58

Bioenergy production represents Canada's second largest renewable energy source. Most bioenergy is produced from organic refuse and used with the facilities in which the energy conversion takes place. The pulp and paper industry produces and uses most of Canada's bioenergy. Industrially produced heat and electricity, independent power producers' electricity, electricity from urban wastes and residential wood heat are all considered commonplace in Canada's energy mix.

Home heating with wood usually takes the form of stand-alone wood stoves, wood furnaces with hot-water or forced-air systems, fireplaces with advanced combustion inserts, high-efficiency fireplaces or high-thermal-mass masonry heaters. About 3 million Canadian households use wood for home heating. Canadians usually prefer roundwood, but alternatives include wood chips and pellets.

Earth Energy

As a result of the sun heating the surface of the planet, the temperature of the earth that is one or two metres below the surface remains fairly constant – between 5°C and 10°C. This is warmer than outside air during the winter and cooler than outside air during the middle of summer. A ground-source heat pump takes advantage of this temperature difference by using the earth or the ground water as a source of heat in the winter and as a "sink" for heat removed from indoor air in the summer. For this reason, ground-source heat pumps are known as earth energy systems (EESs).

During winter, EES installations remove heat from the earth using a liquid, typically an antifreeze solution, that circulates within an underground loop. It then upgrades the heat with a conventional heat pump and transfers it to indoor space or the water-heating system. During summer, the system reverses this process to operate as an air conditioner. EES installations supply less than 1 percent of the market for space and water heating and cooling in Canada.

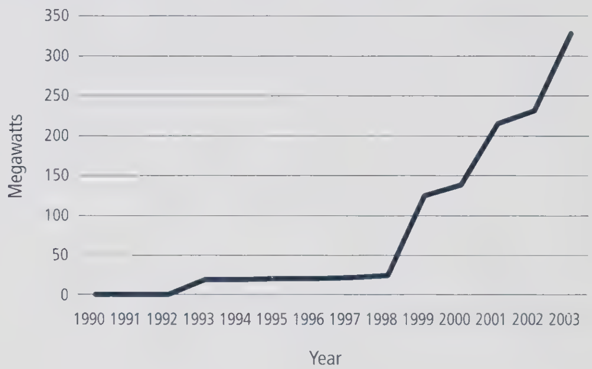
Wind Energy

Wind turbines convert the kinetic energy of wind into electrical or mechanical energy. Canada has a large wind resource potential because of its large size and northern location. A 1992 study by Natural Resources Canada (NRCan) estimated the technical wind energy potential in Canada at about 28 000 megawatts. If developed, this could supply 11 percent of total Canadian electricity consumption. In 2003, wind energy accounted for less that 1 percent of Canada's total electricity generation.

Wind energy also provides mechanical power. Several thousand wind-powered water pumps are used throughout Canada, mostly in the Prairie Provinces. As well, Canadians use small, residential-sized wind turbines to power cottages and remote houses (see Figure 8-1).

Figure 8-1

Canadian Wind Power Capacity, 1990 to 2003



Solar Energy

Three main technologies use energy from the sun:

- passive solar technologies is a term that means buildings are designed and located to maximize their reception of solar energy.
- active solar thermal systems convert solar radiation into thermal energy for heating air or water in residential, commercial and industrial applications.
- solar electric (photovoltaic) systems use solar radiation to produce electricity.

During the 1990s, NRCan assisted a Canadian company in developing a perforated solar absorber to preheat ventilation air and reduce a building's fuel requirements for space heating. This technology is more cost-effective than conventional solar air-heating technologies and is gaining acceptance in Canada and abroad. Systems have been installed on industrial and commercial/ institutional buildings throughout Canada.

The installed photovoltaic power capacity in 2003 was 11.75 megawatts, with an estimated annual production of 10 gigawatt hours of electricity. The bulk of this capacity is "off grid" (not connected to an electrical transmission system), where the price of photovoltaics is competitive with conventional stand-alone power systems or an extension of a grid to a given location.

Typical applications include telecommunications systems, water pumping and purification, remote monitoring and control, remote residences, lighting and beacon systems for the Coast Guard, and numerous consumer applications, such as hand-held calculators. The Canadian Coast Guard is the largest individual user of photovoltaic systems in Canada, with an estimated 7000 navigational buoys, beacons and lighthouses.

Canada has more than 100 grid-connected photovoltaic systems installed on residential rooftops and buildings, providing on-site power with a combined capacity of just over 400 kilowatts. Significant reductions in equipment costs were observed, with Canadian photovoltaic panel prices decreasing to $6.18 per watt in 2003 compared with $11.09 per watt in 1999 (an average reduction of 15 percent per year).

NRCan delivers several initiatives to increase the use of small-scale renewable energy in Canada. The following is the array of NRCan renewable energy programs.

Renewable Energy Programs: ENergy from the FORest (ENFOR)

Objective: To improve the understanding of the role of biomass production for energy and to improve biomass productivity from natural forests and from plantations growing willow and poplar.

ENFOR, managed by the Canadian Forest Service (CFS) of NRCan, undertakes research and development (R&D) on the production and harvesting of forest biomass for energy through the private sector, universities or CFS research centres. ENFOR also investigates the broader environmental effects of harvesting from forests and short-rotation plantation culture, focusing on sustaining forest productivity and improving the sequestration and storage of atmospheric carbon in forest ecosystems. ENFOR also supports research on information systems to determine the quantity and quality of biomass in Canadian forests.

Key 2003–2004 Achievements

- Several species/varieties of willow and poplar have been assessed for production in Ontario, Quebec and the Prairie Provinces. Plantation establishment has been successful in many regions, and industry in western Canada is now engaged in the large-scale planting of fast-growing poplars.
- The CFS, the Canadian signatory to the International Energy Agency (IEA) Bioenergy Agreement, continued its collaboration with a series of workshops, seminars and publications.
- The IEA publication *Biofuels for Transport* describes the activities of tasks working on production of fuels from raw biomass processed into a more convenient form to be used as a fuel. It includes liquid biofuels, wood pellets and briquettes. The position paper *Municipal Solid Waste and its Role in Sustainability* describes the use of household and commercial waste in the energy mix, and the opportunities presented by this energy source.
- Major successes include the further development of the Forest Biomass Inventory of Canada; the modelling of whole-tree harvesting/nutrient cycling; the Carbon Budget Model of the Canadian Forest Sector; and the development and testing of species, clones and the establishment and fertilization of energy plantations.
- The publication *Sustainable Production of Woody Biomass for Energy* by Peter J. Hall was presented at the World Forestry Congress, Québec City, September 2003.

For more information:
nrcan.gc.ca/cfs-scf/science/resrch/bioenergy

Renewable Energy Programs: Initiative to Purchase Electricity From Emerging Renewable Energy Sources

Objective: To purchase electricity from emerging renewable energy sources (ERES) that are certified by a third party as having low environmental impact, with the objective of reducing greenhouse gas (GHG) and other air pollution emissions associated with federal electricity consumption.

Between 1998 and 2001, NRCan entered into three pilot projects to purchase electricity from ERES for federal facilities in Alberta, Prince Edward Island and Saskatchewan. NRCan has pledged to purchase 20 percent of its electricity from ERES by 2010.

Key 2003–2004 Achievements

- The Government of Canada received its second full year of electricity from ERES in Saskatchewan and Prince Edward Island. An estimated 32.4 gigawatt hours (GWh) of electricity from ERES were delivered to the grid in Saskatchewan as well as 13 GWh in Prince Edward Island. These projects resulted in an estimated emissions reduction of 29 000 tonnes of GHGs in Saskatchewan and 11 000 tonnes in Prince Edward Island.
- NRCan also continued to receive 10 000 GWh of electricity from ENMAX Corporation in Alberta. This purchase resulted in GHG emissions reductions of about 9000 tonnes annually.
- The governments of Prince Edward Island and Saskatchewan are purchasing electricity from ERES for their facilities.
- SaskPower constructed a second wind farm in Saskatchewan in fall 2002. This wind farm provides electricity for SaskPower facilities, provincial government facilities and SaskPower's "green" power purchases.
- The governments of Ontario and Alberta committed to purchasing electricity from renewable sources. Ontario targeted 20 percent of its electricity use, and Alberta entered into long-term contracts for 210 GWh annually.
- The Government of Canada issued a Request for Proposals (RFP) in Ontario for the purchase of 90 GWh of electricity from renewable resources, annually, for a period of five years. The RFP closed on December 12, 2003, and the evaluation of the proposals was underway at the end of the fiscal year with a contract award expected early next fiscal year.
- The Government of Canada also initiated or continued negotiations with NB (New Brunswick) Power, Nova Scotia Power and Newfoundland and Labrador Hydro for the purchase of additional quantities of electricity from renewable resources in their respective provinces.

For more information:
nrcan.gc.ca/redi

Renewable Energy Programs: Photovoltaic and Hybrid Systems Program

Objective: To support the development and application of solar photovoltaic technologies and the integration of distributed energy resources to the electrical grid in Canada.

The program contributes to increasing the use of photovoltaic energy technologies in Canada by developing technologies and by facilitating the development of a Canadian-based globally competitive solar industry. It also contributes to the development of policies and programs. In collaboration with Canadian industry and universities as well as international energy research organizations, the program undertakes research and development activities and fosters information exchanges that will encourage the adoption of photovoltaic-hybrid systems that produce electricity from solar energy and another energy source; validates the performance and safety of utility-interactive inverter products; supports the development of building-integrated photovoltaic technologies and systems; and facilitates the development and adoption of harmonized standards and codes for photovoltaic and distributed generation systems in Canada.

Key 2003–2004 Achievements

- Initiated a partnership with Xantrex Technology Inc. to develop and demonstrate a multi-energy (hybrid) technology that will combine and integrate several types of renewable energy (photovoltaic/wind/fuel cell) into a single system with a generator. The system offers an effective alternative energy solution that decreases GHG emissions by reducing fossil fuel use.
- Co-hosted a workshop, in collaboration with the Yukon Energy Solution Centre, to demonstrate the viability of the use of renewable energy in off-grid residences in Canadian northern communities.
- Championed a national initiative to facilitate the acceptance of utility-interactive inverters and simplified grid-interconnection requirements for renewable energy generation to become part of the electricity supply in Canada.

For more information:
cetc-varennes.nrcan.gc.ca/en/er_re.html

Renewable Energy Programs: RETScreen® International Clean Energy Decision Support Centre

Objective: To build the capacity of planners, decision-makers and industry to implement renewable energy and energy efficiency projects.

This objective is achieved by developing decision-making tools that reduce the cost of pre-feasibility studies, by disseminating knowledge to help people make better decisions, and by training people to better analyse the technical and financial viability of possible projects.

Key 2003–2004 Achievements

- Increased the number of users of the RETScreen International Clean Energy Project Analysis Software to more than 43 000 people in 200 countries and trained 1123 planners, decision-makers, professors and other professionals via the delivery of 28 RETScreen training seminars across Canada and 11 internationally with a number of partners.
- Released Version 3.0 of the RETScreen Wind Energy and Small Hydro Project Models in partnership with the World Bank's Prototype Carbon Fund and the United Nations Environment Programme, which incorporates an improved GHG emissions baseline tool to account for the emerging rules under the Kyoto Protocol.
- Developed a new Combined Heat and Power (CHP) Model for RETScreen, and initiated the development of a new Refrigeration Project Model for applications such as supermarkets and ice rinks.

For more information:
www.retscreen.net

Renewable Energy Programs: Bioenergy Technology Program

Objective: To support efforts by Canadian industry to develop bioenergy technologies.

Technologies supported include combustion, biochemical conversion of biomass to ethanol, thermochemical conversion of biomass to bio-oil and biogas, and biomass preparation and handling. Activities are directed toward improving the reliability and lowering the cost of technologies, disseminating information on technology feasibility and economics to potential users, and helping industry commercialize its products in domestic and foreign markets.

Key 2003–2004 Achievements

- With ongoing support from NRCan and other federal departments, Iogen Corporation is continuing on a successful path to full-scale commercialization of its process for producing fuel ethanol from agricultural residues, such as straw. Iogen Corporation successfully doubled its capability to produce fermentable sugar from wheat straw in its pre-commercial demonstration plant. The company can now process 50 tonnes per week of wheat straw to sugars and is on target to produce over 700 000 litres of ethanol annually.
- NRCan supported the University of Toronto (U of T) in the development of an innovative technology that can convert any seed oil, waste grease, and animal fat and tallow into high quality biodiesel fuel. The technology produces biodiesel at ambient pressure and low temperature to yield a superior product at a significant cost reduction, both in capital cost and operational cost. U of T licensed the process to the BIOX Corp. of Oakville, Ontario, which successfully demonstrated in a million-litres-per-year pilot plant that the process can cost-effectively convert high fatty acid feedstocks into biodiesel. BIOX also recently received support from the Sustainable Development Technology Canada (SDTC) program to build a 60-million-litres-per-year commercial demonstration plant.
- Canadian biomass companies have received funding support from agencies such as SDTC, the Federation of Canadian Municipalities, Technology Partnerships Canada and provincial/territorial agencies to build the first industrial demonstrations of pyrolysis technologies that will convert wood residues to heat, power and electricity. The successful demonstration of these processes – that have higher conversion efficacies than straight combustion systems – will help to accelerate their introduction into the energy field.
- Earth (Canada) Corporation was hired by the City of Edmonton to evaluate all gasification technologies worldwide to determine their technical and economic suitability for a municipal solid waste application for the city – 150 international technologies were reviewed, 11 were found to be technically acceptable. Enerkem Technologies, based in Sherbrooke, Quebec, was ranked in the top three technologies overall and was also ranked first for the lowest-cost technology.

For more information:
www.canren.gc.ca/bio/index.asp

Renewable Energy Programs: Renewable Energy Deployment Initiative (REDI)

Objective: To stimulate the demand for renewable energy systems by helping the supply industry in its marketing and infrastructure development efforts, including the provision of financial incentives.

REDI targets four systems: solar water heating, solar air heating, earth energy, and high-efficiency, low-emissions biomass combustion. REDI promotes these systems in the business, federal and industrial markets through three means: a financial incentive, market assessment, and information and awareness.

Key 2003–2004 Achievements

- Distributed $2.5 million in REDI financial incentives among 89 projects valued at $22 million; the projects were completed in 2003–2004.
- Collaborated with the Association of Canadian Community Colleges to support the development of a national renewable energy training strategy to be delivered across the college and institute network.
- Sponsored a renewable energy course for architects in partnership with the Royal Architectural Institute of Canada.
- Supported innovation by expanding the list of technologies supported to include another solar air-heating technology and paid for its testing at the National Solar Test Facility.
- In collaboration with the Canadian Electricity Association and the Geothermal Heat Pump Consortium, Inc., signed a contribution agreement to establish the Canadian GeoExchange Coalition to promote earth energy in Canada.
- In collaboration with industry partners, produced several new publications on renewable energy, including *Micro-Hydropower Systems – A Buyer's Guide; Performance Directory of Solar Pool Collectors*; and *REDI, Set, Go – Toolkit for Municipalities*.

For more information:
nrcan.gc.ca/redi

TABLE 8-3

REDI for Business Projects Completed, 1998 to 2004

	Number of projects completed	*Estimated GHG reduction (tonnes CO_2/yr.)*	*Cost of system*	*NRCan contribution*
1998–1999	8	2869.0	$1,306,295	$145,950
1999–2000	9	260.8	$479,633	$119,910
2000–2001	24	5825.4	$1,849,918	$327,078
2001–2002	43	21.7	$5,827,561	$1,197,965
2002–2003	33	5718.8	$2,745,834	$606,210
2003–2004	89	39 653.5	$22,356,375	$2,551,845
Total	**206**	**54 349.2**	**$34,565,616**	**$4,948,958**

Renewable Energy Programs: Renewable Energy Technologies (RET) Program

Objective: To promote energy diversity and support efforts by Canadian industry to develop renewable energy technologies.

This program supports the continued improvement of the economics and efficiency of renewable energy technologies. Technologies supported include bioenergy (combustion, biochemical conversion of biomass to ethanol, thermochemical conversion of biomass to bio-oil and biogas, and biomass preparation and handling), small hydro projects (less than 20 megawatts), active solar applications and wind energy.

Canada is a world leader in the production of renewable energy, with about 18 percent of its primary energy supply coming mainly from two sustainable sources: water (12 percent) and biomass (6 percent). Emerging renewable energy sources such as wind power and solar energy, both for heating and electricity generation, are rapidly gaining in importance and acceptance by utilities and industry.

Key 2003–2004 Achievements

- Funded work toward the development of new and improved engineering designs of small (less than 20 megawatts) hydro power plant equipment to increase efficiency and reduce costs.
- Helped establish an independent hydro turbine testing laboratory at Université Laval that provides research support to hydro turbine manufacturers such as GE Hydro and NORCAN Hydraulic Turbine Inc.
- Played a key role in establishing the manufacturing of efficient and cost-competitive small wind turbines (in the 10–275 kilowatt range) in Canada.
- Supported a project to further develop and improve the Wind-Diesel Integration Control (WDIC) system that now includes wind-diesel hybrid systems for remote communities also using hydrogen, biogas and batteries.
- Supported Frontier Power Systems of Prince Edward Island's installation of a wind/diesel project on Ramea Island, Newfoundland and Labrador, the first installation of this kind in Canada – a project that will reduce carbon dioxide (CO_2) emissions by about 750 tonnes per year.

For more information:
canren.gc.ca

Renewable Energy Programs: Wind Power Production Incentive (WPPI)

Objective: The WPPI is a 15-year, $260-million program to support the installation of 1000 megawatts of new wind energy capacity by March 31, 2007.

The WPPI encourages electric utilities, independent power producers and other stakeholders to gain experience in wind power, an emerging energy source. The incentive is approximately $0.01 per kilowatt hour of production and represents about half of the current cost of the premium charged for wind energy in Canada for facilities where good wind resources exist. Eligible recipients can receive the incentive for 10 years.

By displacing other electricity sources and through continued momentum, wind-power capacity installed under the WPPI is projected to reduce GHG emissions by 3 megatonnes annually by 2010.

Key 2003–2004 Achievements

- The program received 39 additional letters of interest for 2800 megawatts of wind-energy projects from developers, utilities and businesses. By the end of the fiscal year, four new projects were completed, for a total new capacity of about 15 megawatts. Two projects were in Prince Edward Island (8.3 megawatts), one in Saskatchewan (4.6 megawatts), and one in Quebec (2.3 megawatts) resulting in a commitment of more than $5.1 million of incentive payments over 10 years.
- Developed guidelines to assist wind developers, utilities and businesses in their submission of an Environmental Impact Statement under the *Canadian Environmental Assessment Act*. The *Environmental Impact Statement Guidelines for Screenings of Inland Wind Farms* are available from the program or on the WPPI Web site.

For more information:
canren.gc.ca/wppi

Renewable Energy Programs: Market Incentive Program (MIP)

Objective: The MIP is a $25-million program to stimulate emerging markets for renewable electricity. Funding is available until March 31, 2006.

Under the program, electric utilities, retailers and marketers submit proposals for consideration by NRCan and Environment Canada for projects to develop market-based programs and promote the sale of electricity from emerging renewable sources, having low environmental impact, to residential and small-business customers. The Government of Canada is to provide a short-term financial incentive of up to 40 percent of the eligible costs of an approved project, to a maximum contribution of $5 million per recipient.

The program's CO_2 reduction objectives are 1.4 megatonnes per year by 2010.

Key 2003–2004 Achievements

- Received 19 new proposals.
- Signed three contribution agreements with New Brunswick, Ontario and Prince Edward Island. The agreements could result in 28 715 new customers, 136 000 megawatt hours of incremental electricity and 107 kilotonnes of CO_2 emission reductions by 2006.
- Eight additional contribution agreements under negotiation.

For more information:
www2.nrcan.gc.ca/es/erb/erb/english/View.asp?x=457

Chapter 9: Federal House in Order

Introduction

The Government of Canada is the country's largest single enterprise. It is working to get its house in order by setting a target of a 31 percent reduction in greenhouse gas (GHG) emissions from its own operations by 2010.

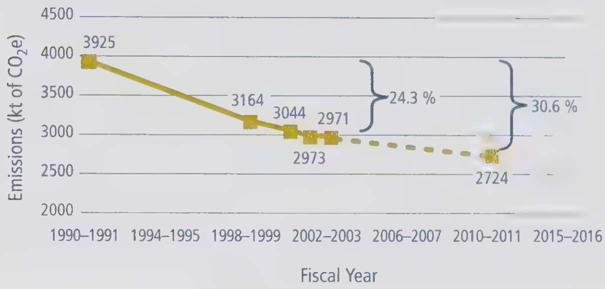
Since 1990, through building retrofits, better fleet management, strategic "green power" purchases and the downsizing of operations, the Government of Canada has already achieved a 24 percent emissions reduction. The Government of Canada will reduce its net emissions by a further 12 percent by 2010.

The Government of Canada will achieve its goal by additional building retrofits, fuel switching, improved fleet management, energy-efficient procurement and increased use of renewable energy within government operations. Moreover, the Government of Canada can help to "create the market" for certain new technologies on the verge of becoming viable. Key departments, which are responsible for 95 percent of government GHG emissions, have been assigned specific targets and must report annually on their progress.

The task of target sharing entails assigning specific targets to the 11 largest emitting departments based on the emission-reduction opportunities identified within each organization. Natural Resources Canada (NRCan) is taking a lead role in managing this task and in providing programs and support to departments and agencies that will help them achieve their targets. A leadership component of the Federal House in Order encourages the reduction of all federal emissions by engaging the active participation of the departments, agencies and Crown corporations that were not designated with a target.

FIGURE 9-1

GHG Emissions Reductions From Federal Operations, 1990–1991 to 2010–2011



Federal Buildings Initiative (FBI)

Objective: To assist Government of Canada organizations in implementing energy efficiency improvements, leading to reduced energy use, GHG emissions and operating costs.

The FBI facilitates comprehensive energy efficiency upgrades and building retrofits for departments, agencies and Crown corporations of the Government of Canada. The FBI provides advice and consultation on project opportunities, model performance contracting documents, celebration and recognition opportunities, and a national network for energy management training. In facilitating public-private partnerships, the FBI manages a qualified list of energy management firms that provide a turnkey service to federal organizations including project engineering and construction, third-party private sector financing, project monitoring, and employee training and awareness. FBI program officers work with federal organizations from project inception through to contract award and project monitoring and verification.

Key 2003–2004 Achievements

- Five new FBI contracts were awarded.
- The private sector invested $25.6 million in FBI projects.
- Average energy intensity improvement of 20 percent by project.

For more information:
oee.nrcan.gc.ca/fbi/home_page.cfm

Federal Industrial Boiler Program (FIBP)

Objective: To provide technical and project management services to assist federal facilities in implementing energy-reduction projects.

The FIBP's extensive experience in building energy systems and access to the engineering and scientific network within the CANMET Energy Technology Centre ensures that environmentally responsible technologies are considered when federal government clients replace or modify their space heating and cooling systems. Since its inception in 1991, the FIBP has worked with many departments, including Agriculture and Agri-Food Canada, Correctional Service Canada (CSC), the Department of National Defence, Environment Canada, and the Department of Foreign Affairs and International Trade (now divided into Foreign Affairs Canada and International Trade Canada), to reduce their energy costs. Under the FIBP, GHG emissions are reduced by an average of 4.7 kilotonnes per year.

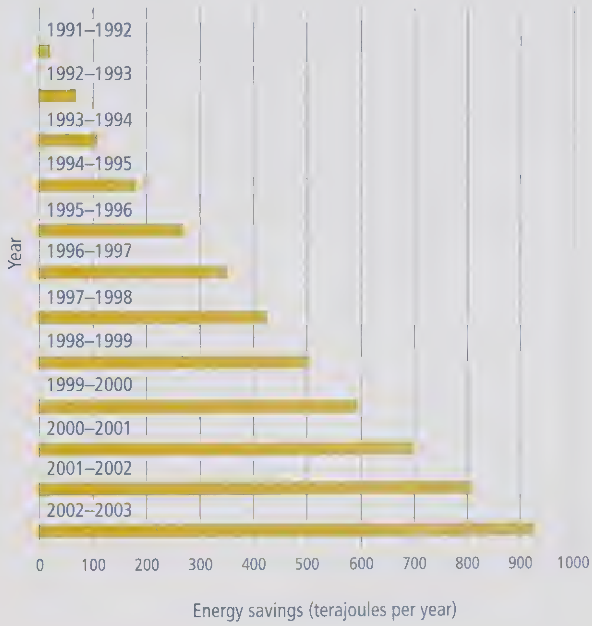
Key 2003–2004 Achievements

- Worked with Agriculture and Agri-Food Canada, CSC, NRCan, and Public Works and Government Services Canada to develop project proposals for the Federal House in Order initiative. The projects included wind turbines, ranging in size from 20 to 1000 kilowatts, a Solarwall® application, an innovative heating, ventilation and air-conditioning (HVAC) heat recovery system, and improved building heating achieved by converting to local high efficiency heaters. Five projects were approved for funding. Once implemented, they will reduce annual carbon dioxide emissions by 668 000 kilograms.
- Worked with CSC sites in the Kingston, Ontario, area to review heating plant operations and develop options to reduce operating costs and environmental emissions. Thirty-year life cycle costs of various options were developed for Kingston Penitentiary and Collins Bay Institution. These identified options that could reduce annual operating costs by $230,000 and $200,000, respectively.
- Reviewed CSC's Springhill Institution heating plant operation and developed a plan for upgrading controls for fully automatic operation. Implementation proceeding in fiscal year 2004–2005.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/research_programs_fibp_e.html

FIGURE 9-2

Annual Energy Savings From the FIBP, 1991–1992 to 2002–2003



Federal Vehicles Initiative

Objective: To assist federal government departments in increasing the energy efficiency of their motor vehicle fleets and reducing the environmental impact of federal vehicle operations and to promote the *Alternative Fuels Act* within the federal fleet.

The Initiative provides fleet managers with an assessment of fleets as well as technical advice and encouragement on acquiring and using alternative transportation fuels. Four departments participate in planning and reporting on the Initiative: Environment Canada, NRCan, Public Works and Government Services Canada, and Treasury Board of Canada Secretariat. NRCan is responsible for implementing the program.

Key 2003–2004 Achievements

- Established three new alternative fuel sites; two additional sites are under construction.
- Trained 1445 federal vehicle operators at workshops; trained an additional 205 operators on-line.
- Acquired 377 Leadership Vehicles, 293 of which were alternative fuel vehicles, in compliance with the *Alternative Fuels Act*.

For more information:
oee.nrcan.gc.ca/greening/home.cfm

FIGURE 9-3

Federal Fleet Size and Fuel Consumption, 1995–1996 to 2002–2003

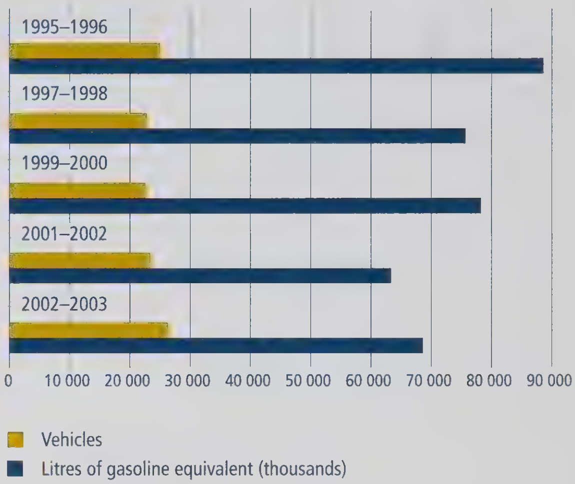


FIGURE 9-4

Purchases of Alternative Fuel Vehicles for the Federal Fleet, 1997–1998 to 2003–2004

Chapter 10: General Programs

Outreach

Objective: To increase Canadians' awareness and understanding of climate change and the link to energy use, and to encourage Canadians to take action.

The Outreach program provides information and activities to encourage Canadians to integrate energy efficiency into their energy-use decisions. Outreach supplements program communications activities with publications, exhibits, joint projects and the Office of Energy Efficiency (OEE) Web site.

The Outreach program targets youth as future energy consumers by investing in joint initiatives in the education sector and through promotional projects. Public information activities increase awareness of the environmental impact of energy use. They also encourage consumers to adopt energy-efficient practices and to switch to alternative forms of energy.

As a component of the Outreach program, the One-Tonne Challenge was launched in March 2004. The One-Tonne Challenge is co-managed with Environment Canada, with input from and coordination with other departments, such as Transport Canada. The One-Tonne Challenge asks Canadians to reduce annual greenhouse gas emissions by one tonne. Canadians are challenged to use less energy, to reduce waste and to conserve water and other resources. Reduced emissions will protect the climate and result in cleaner air and healthier communities for all Canadians.

Key 2003–2004 Achievements

- Increase of 30 percent in the volume of publications distributed and a 300 percent increase in Web site visits, indicating increasing interest in energy efficiency.
- Baseline polling indicated that 81 percent of Canadians believe that their actions to increase energy efficiency will pay off.
- *Energy and the Environment* calendar (7072 submissions received – 144 000 calendars distributed) participation increased by 45 percent; visits to the Web site for the calendar increased (13 percent).
- Energy Ambassadors – Student Competition: 75 projects received – 19 awards presented to 38 students.
- Canada's Energy Efficiency Awards – 179 nominations received – 15 awards presented.
- OEE extended six provincial/territorial co-funded Public Education and Outreach Hubs for two years.
- Climate change educational material has been linked to provincial curricula across Canada and workshops are underway to reach elementary and secondary teachers.

For more information:
oee.nrcan.gc.ca/corporate/programs.cfm#outreach

Program of Energy Research and Development (PERD)

Objective: To fund research and development (R&D) designed to ensure a sustainable energy future for Canada in the best interests of our economy and our environment.

The PERD budget for 2003–2004 was approximately $58 million. Natural Resources Canada (NRCan) allocated $41.5 million to energy R&D programs managed and performed in the department, approximately 50 percent of which contributed to improved energy efficiency in Canada. Examples of funded projects are included in the performance reporting in Chapters 4–8 of this report. The remaining $16.5 million was allocated to 10 federal departments that are partners in PERD.

For more information:
www2.nrcan.gc.ca/es/oerd/english/View.asp?x=665

Climate Change Technology Development and Innovation Program (of the *Government of Canada Action Plan 2000 on Climate Change*)

Objective: To accelerate the development of cost-effective R&D mitigation technologies in multiple sectors, building the intellectual foundation for long-term technological advances, building alliances and partnerships and demonstrating federal leadership towards sustainable development.

The Climate Change Technology Development and Innovation Program received $20 million over six years (2001–2006) as a part of *Action Plan 2000 on Climate Change*.

Key 2003–2004 Achievements

- Developed and demonstrated novel mitigation technologies in the second year of the Innovative Research Initiative, aimed at federal, provincial and territorial research organizations. A total of 33 R&D projects are nearing completion, and 15 new projects received incubation funding to undertake novel next-generation R&D.

For more information:
www2.nrcan.gc.ca/es/oerd/english/View.asp?x=658

International Initiative for Technology Development Program

Objective: To identify and develop technology transfer projects and facilitate the expansion of market opportunities for climate change technologies.

The International Initiative for Technology Development Program received $10 million over six years (2001–2006) as part of *Action Plan 2000 on Climate Change*.

Key 2003–2004 Achievements

- Provided funding to nine new feasibility studies.
- Launched the Clean Energy Portal and provided marketing support at five national and international conferences.
- Organized numerous outgoing and incoming missions to promote Canadian technology transfer.

Climate Change Technology and Innovation Research and Development and Innovation Program

Objective: To contribute to the *Climate Change Plan for Canada* objective to "advance promising GHG technologies through R&D, demonstration and early adoption initiatives to achieve long-term GHG reductions and strengthen Canada's technology capacity."

Implemented in 2003 with $115 million over five years of federal funding, T&I R&D is based on long-term strategic planning that takes into account expected energy futures and visions to the year 2025. R&D is conducted in the five strategic areas of cleaner fossil fuels, advanced end-use efficiency technologies, decentralized energy production (including renewables), biotechnology and the hydrogen economy.

The T&I R&D budget for 2003–2004 was $6.4 million. NRCan allocated $5.1 million to energy R&D programs managed and performed in the department. A targeted Request for Proposals focused on R&D, strategic and scoping studies, and infrastructure renewal. Key NRCan R&D achievements that contributed to improved energy efficiency in Canada are included in the performance reporting in Chapters 4–8 of this report. The remaining $1.5 million was allocated to six federal departments that are partners in T&I R&D.

Chapter 11: Intergovernmental Cooperation

Introduction

This chapter describes Natural Resources Canada's (NRCan's) intergovernmental cooperation with respect to efficiency and alternative energy (EAE) during the reporting period at the provincial/territorial and international levels. Other examples of intergovernmental cooperation are set out in previous chapters in the Key Achievements sections of specific EAE program initiatives. It also should be noted that municipal governments and agencies participate in NRCan's EAE measures as clients (e.g. for training workshops; as recipients of financial incentives) and partners (e.g. in anti-idling projects). NRCan also participates in ventures led by municipal organizations (e.g. Green Municipal Funds, as explained in the accompanying textbox) and provincially/territorially regulated electricity and provincially regulated natural gas utilities.

Green Municipal Funds

- The Green Municipal Funds were created in Budget 2000 by an endowment of $125 million to the Federation of Canadian Municipalities (FCM). The funds were doubled in Budget 2001 to the current total of $250 million – $50 million for the Green Municipal Enabling Fund and $200 million for the Green Municipal Investment Fund.
- The Government of Canada signed an Agreement with the FCM, a non-profit organization, to deliver the Green Municipal Funds. Under the agreement, the Government of Canada (NRCan and Environment Canada) shares in the governance of the Green Municipal Funds, along with representatives from the public and private sectors, including municipal officials and technical experts, through participation on a Peer Review Committee and a governing Council. The FCM Board of Directors reviews council recommendations and decisions.

Federal-Provincial and Federal-Territorial Cooperation

Provincial and territorial governments assisted the delivery of a substantial number of EAE programs during the reporting period to reduce energy costs, increase competitiveness, improve air quality and generate economic and trade opportunities. Coordination between the federal and provincial/territorial levels is essential to avoid duplication and ensure efficient program delivery. During the reporting period, the governments cooperated at the general level and at the level of specific program initiatives.

General Cooperation

Cooperation Agreements

- NRCan's Letter of Cooperation (LOC) on EAE with the Agence de l'efficacité énergétique du Québec during the reporting period ensures an efficient consultation and exchange of information between the two governments, and helps the coordination of EAE activities in the province and the creation of opportunities for joint projects. The management committee established under the LOC met during the year to review policy and program developments, progress on joint program initiatives and areas for further cooperation. The LOC played a considerable role in facilitating the conduct of three activities in particular:
  - management of the licensing agreement for delivery of EnerGuide for Houses.
  - the processing of projects submitted to the Energy Innovators Initiative and the Commercial Building Incentive Program by public organizations in Quebec. This cooperation framework is also being applied to other NRCan programs aimed at the public sector in Quebec.

– management of an agreement relating to the Programme d'intervention en réfrigération dans les arenas du Québec, under which NRCan has provided technical support for the implementation of innovative refrigeration systems in Quebec's ice rinks.

- NRCan's LOC on energy efficiency and renewable energy with the Government of Yukon facilitates information exchange and the creation of opportunities for joint projects in Yukon, including partnering with the Yukon Development Corporation to create the Canada-Yukon Energy Solutions Centre in Whitehorse. The Centre provides access to relevant technical services and programs for the Yukon population and undertakes outreach and public education activities.
- The Government of Canada contributes to the Arctic Energy Alliance to promote energy efficiency and renewable energy in the Northwest Territories and to facilitate opportunities for EAE projects. The Alliance also is the delivery agent in the Northwest Territories for the EnerGuide for Houses initiative.
- The Government of Canada promotes energy efficiency and renewable energy in Alberta by working with Climate Change Central, a not-for-profit corporation which is funded by a multi-stakeholder base, including the Government of Alberta.

National Advisory Council on Energy Efficiency (NACEE)

- NRCan created NACEE in April 1998 to advise and guide the Office of Energy Efficiency (OEE) on the most effective way to achieve its mission. Its membership is drawn from across Canada and all economic sectors, including provincial/territorial officials and representatives of electricity and natural gas utilities, who have the opportunity to comment on the OEE's business plan and programs. NACEE met three times during 2003–2004.

Examples of Cooperation at the Program Level

R-2000 Standard and EnerGuide for Houses

- The Government of Canada contributes towards the delivery of R-2000 and EnerGuide for New Houses by the Yukon Housing Corporation. The Corporation also delivers EnerGuide for Houses in the existing housing market in the territory.
- In New Brunswick, Newfoundland and Labrador, Nova Scotia and Saskatchewan, the provincial governments and NRCan supported R-2000 through financial or in-kind contributions. Saskatchewan also supports marketing of EnerGuide for Houses in that province.
- In Manitoba and Yukon, the provincial and territorial governments delivered R-2000 under a licensing agreement with NRCan.
- In Quebec, the Agence de l'efficacité énergétique du Québec has incorporated the R-2000 Standard into its Novoclimat Initiative. The Agence also coordinates the delivery of EnerGuide for Houses in the province.
- Manitoba Hydro has incorporated the R-2000 Standard and EnerGuide for Houses into its Power Smart initiatives.
- British Columbia Hydro offers a financial incentive for energy-efficient residential retrofits, based on the EnerGuide for Houses service.

Federal Buildings Initiative (FBI)

- British Columbia and New Brunswick have replicated several elements of the FBI into programs aimed at improving the energy efficiency and environmental performance of their buildings.

Commercial Building Incentive Program (CBIP)

- Provinces and territories distributed information on CBIP.
- Provincial and territorial health and education departments were active participants in the program as eligible parties.
- NRCan works with the Agence de l'efficacité énergétique du Québec to facilitate the participation of public organizations in the initiative.
- The province of Alberta, through the Energy Solutions Alberta initiative of Climate Change Central, implemented a pilot program providing additional financial incentives to projects approved by CBIP.
- The province of Saskatchewan announced a new policy mandating CBIP compliance for provincial buildings receiving at least 30 percent government funding.

Canadian Industry Program for Energy Conservation (CIPEC)

- NRCan collaborated with the Agence de l'efficacité énergétique du Québec, Hydro-Québec and Gaz Métro in Quebec; with Enbridge and Union Gas in Ontario; and with Manitoba Hydro and BC Hydro on funding industrial energy audits of companies within their jurisdictions. As well, provincial government and utilities in the provinces of Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Manitoba, Saskatchewan, Alberta and British Columbia collaborated with CBIP to deliver industrial energy efficiency information sessions.

Energy Innovators Initiative (EII)

- The EII relies on partners to promote energy efficiency and facilitate access to its members as well as to provide sectoral information. Partners include the Association of Canadian Community Colleges, the Canadian School Boards Association, the Canadian College of Health Service Executives, the Association des gestionnaires de parcs immobiliers institutionnels, and the Ontario Hospitals Association.
- A dynamic partnership has been established with BC Hydro to assist in identifying new retrofit projects with large energy users.
- EII established a collaboration with Hydro-Québec to hold joint promotional activities, as well as to explore ways to harmonize each party's programs.
- The EII works with the Agence de l'efficacité énergétique du Québec to facilitate program delivery to the province's institutional sector.

Equipment *Energy Efficiency Regulations* and Labelling

- NRCan and five provinces (British Columbia, New Brunswick, Nova Scotia, Ontario and Quebec) regulate the energy efficiency performance of prescribed equipment. They share information and consult through the Canadian Standards Association's Advisory Committee on Energy Efficiency.
- Incentive rebate programs for the purchase of ENERGY STAR® qualified equipment were conducted, in cooperation with NRCan, by BC Hydro and Terasen Inc. (British Columbia), Climate Change Central (Alberta), the Province of Saskatchewan, Union Gas (Ontario), Enbridge Gas Distribution (Ontario) and Enbridge Gas New Brunswick.
- NRCan worked with Manitoba Hydro and the City of Winnipeg on a demonstration of the use of LED (light emitting diode) traffic lights in severe climates. It undertook a pilot program with British Columbia Hydro to promote the purchase and use of LED seasonal lights.

Initiative to Purchase Electricity From Emerging Renewable Energy Sources

- The February 2000 federal budget announced that the Government of Canada would expand the pilot Green Power Initiative to procure $15 million of renewable energy over the next 10 years in Saskatchewan and Prince Edward Island. By early 2001, agreements were reached with SaskPower and Maritime Electric on the purchase of "green" power for federal facilities in the provinces they serve.

Market Incentive Program for Distributors of Electricity From Emerging Renewable Energy Sources

- Announced in October 2002, this program provides a limited financial incentive towards projects aimed at developing market-based programs and promoting the sale of electricity from emerging renewable sources to residential and small-business customers. Agreements have been signed with Selectpower, a subsidiary of Guelph Hydro Inc. (Ontario), NB (New Brunswick) Power and Maritime Power (Prince Edward Island).

Residential Wood Combustion

- NRCan is a member of the Intergovernmental Working Group on Residential Wood Combustion, which includes representatives from municipal, provincial, territorial and federal governments. The Working Group was formed in 1999 to promote and coordinate government actions on the sustainable development of residential wood combustion. Its first priority was to address four components related to residential wood combustion under the Joint Initial Actions on the Canada-wide Standards for fine particulate matter ($PM_{2.5}$) and ozone. Under these actions, governments committed to participating in new initiatives to reduce emissions from residential wood-burning appliances, including:
  - an update of the Canadian Standards Association's standards for new wood-burning appliances

– development of a national regulation for new, clean-burning residential wood heating appliances
– national public education programs
– an assessment of the option of a national wood stove upgrade or change-out program

Personal Vehicles and Vehicle Fuels

- In Ontario, the Municipalities of Mississauga, Ottawa, Caledon and the Greater Toronto Area are active members of NRCan's vehicle anti-idling campaign. Other campaigns have been successfully completed in Calgary, Edmonton, Sherbrooke and Québec City.
- All provinces and territories have agreed to include fuel efficiency messaging provided by NRCan in their next version of basic drivers handbooks.
- NRCan co-chairs the federal-provincial/territorial Council of Energy Ministers' Working Group on Biofuels.

Program of Energy Research and Development (PERD)

- NRCan manages this 30-year program that funds energy research and development through 12 federal departments.
- Research and development is performed in federal facilities located across Canada and is also supported by the provinces/territories and industry.

Technology and Innovation Research and Development (T&I R&D)

- Announced in 2003 as part of the *Climate Change Plan for Canada*, this five-year interdepartmental initiative will accelerate the development of technologies to help achieve GHG reductions in the longer term.
- Energy efficiency will be a key element of energy R&D programs targeted in the areas of cleaner fossil fuels, advanced end-use efficiency technologies, decentralized energy production (including renewables), biotechnology and the hydrogen economy.

International Cooperation

NRCan cooperates with several international organizations and foreign governments in EAE program areas. Canada benefits from this cooperation:

- by learning about improved ways of designing and delivering EAE programs to meet policy objectives
- through the harmonization of energy efficiency tests and performance standards that helps reduce barriers to trade in energy-using products

International Energy Agency (IEA)

The IEA, based in Paris, France, is an autonomous agency within the framework of the Organisation for Economic Co-operation and Development. The IEA carries out a comprehensive program of energy cooperation among its 26 member countries, including Canada. IEA member governments have committed to sharing energy information, coordinating energy policies and cooperating in the development of rational energy programs. The IEA and its Governing Board are assisted in their work by several standing groups and special committees, which bring together energy specialists from member countries.

The Standing Group on Long-Term Cooperation (SLT) is the key committee on the policy side. It analyses policies to promote conservation and the efficient use of energy, the increased use of alternatives to oil and other measures to increase long-term energy security while protecting the environment. The SLT monitors energy developments in member countries and makes recommendations on energy policy through a regular series of individual country reviews. The Energy Efficiency Working Party (EEWP) of the SLT undertakes IEA work on specific issues related to energy efficiency. Canada is represented at the EEWP by NRCan's Office of Energy Efficiency. In 2003, the IEA conducted an in-depth review of Canada's energy policies, including EAE policies and measures.

NRCan is a member of the Centre for Analysis and Dissemination of Demonstrated Energy Technologies (CADDET), established under the IEA Agreement on Energy and Environmental Technologies Information Centres. CADDET is an international information network that helps managers, engineers, architects and researchers find out about energy-using technologies that have worked in other countries.

Canada also collaborates with research centres in member countries on several agreements and programs oriented toward R&D and technology. NRCan facilitates R&D and commercial business ventures abroad by Canadian firms by undertaking a wide variety of activities, including participating in various IEA tasks and supporting technical and trade-oriented workshops and conferences.

United Nations

RETScreen® International is managed under the leadership of NRCan's CANMET Energy Technology Centre – Varennes (CETC–Varennes) through cost- and task-shared collaborations with other governments and multilateral organizations, and with technical support from experts in industry, government and academia. Key partners are the United Nations Environment Programme's Energy Unit of the Division of Technology, Industry and Economics; Global Environment Facility-sponsored Sustainable Alternatives Network; Risoe Centre on Energy, Climate and Sustainable Development; and the Solar and Wind Energy Resource Assessment project. Other international partners include the World Bank's Prototype Carbon Fund; the National Aeronautics and Space Administration's Langley Research Center; the Barbados Ministry of Energy and Public Utilities; the United States Agency for International Development; and the Korean Institute for Energy Research.

China

In February 2001, Canada and China signed a Memorandum of Understanding (MOU) on Energy Cooperation. In January 2003, they signed an MOU on climate change and the Clean Development Mechanism. Energy efficiency is among the areas of cooperation identified in both MOUs.

The Federal Buildings Initiative of NRCan's OEE participated in a workshop on "government energy management programs" organized by the China Certification Center for Energy Conservation Product and the Lawrence Berkeley National Laboratory of the United States Department of Energy and held in Beijing, China. The event brought together leading experts in the field of energy efficiency management and government efficiency management.

Mexico

NRCan signed a MOU on EAE cooperation with the Mexican Energy Secretariat in June 1996. Its objective is to contribute to the EAE objectives of Canada and Mexico by improving the design and delivery of EAE programs and enhancing trade, investment and exchanges (technical and other) related to energy-efficient products, energy management services and alternative energy goods and services.

United States

NRCan and the U.S. Department of Energy (DOE) have an MOU on road transportation, energy efficiency and alternative fuels. It provides a formal mechanism for negotiating and harmonizing North American policy on fuel efficiency, fuel quality and alternative transportation fuels. The MOU provides a framework for joint projects and studies in areas of mutual interest, such as the costs and market potential of hybrid electric-powered and diesel-powered vehicles. The MOU facilitates bilateral discussion of a broad range of issues in the motor vehicle and fuels policy area and affords access to technology assessments and policy-related studies conducted for the DOE by its national laboratories. In 2003–2004, a study was begun on hybrid and diesel powertrains in the U.S. light-duty vehicle market. Diesel and hybrid technologies each have the potential to reduce light-duty vehicle fuel consumption by 25 percent or more without loss of performance, yet these technologies have typically been excluded from technical assessments of fuel economy potential on the grounds that hybrids are too expensive and diesels cannot meet Tier 2 emissions standards. The study takes a detailed look at the market potential of these two powertrain technologies and their possible impacts on light-duty vehicle fuel consumption.

United States and Mexico

NRCan continues to participate with the United States and Mexico in the North American Energy Working Group's (NAEWG's) Energy Efficiency Experts Group to promote the harmonization of energy efficiency test methods, mutual recognition of conformity assessment systems for energy efficiency standards and cooperation on trilateral energy efficiency labelling programs. During the review period, work was initiated to compare test standards for central air conditioners and transformers and other products. Mexico continued to review implementation of ENERGY STAR® and adoption of a new approach, developed in Canada and the U.S., for promoting the replacement of inefficient electric motors. A trilateral stakeholder meeting was held in conjunction with the annual meeting of the Council for the Harmonization of Electrotechnical Standards for the Nations of the Americas, which provided feedback on ways for more effective interaction between the group and the NAEWG.

Appendix 1: NRCan's Efficiency and Alternative Energy Initiatives and Expenditures, 2003–2004

(millions of dollars)

Energy Efficiency – Equipment **$22.0**

Energy Efficiency Standards and Regulations
Equipment Labelling and Promotion
EnerGuide for Industry
Mine Ventilation

Energy Efficiency – Housing and Buildings **$41.5**

R-2000 Standard and EnerGuide for (New) Houses
Super E™ House Program
EnerGuide for Houses and Retrofit Incentives
Housing Energy Technology Program
Commercial Building Incentive Program
Industrial Building Incentive Program
Green Buildings Program
Federal Buildings Initiative
Federal Industrial Boiler Program
Energy Innovators Initiative
Buildings Program – Refrigeration Systems
Buildings Program – Intelligent Buildings
Building Energy Simulation Program
Community Energy Systems Program

Energy Efficiency – Industry **$30.4**

Industrial Energy Efficiency (Canadian Industry Program for Energy Conservation; Industrial Energy Innovators)
Cleaner Fossil Fuel Power Generation
Processing and Environmental Catalysis Program
Industrial System Optimization Program
Industry Energy Research and Development Program
Emerging Technologies Program
Industrial Energy Innovation
Minerals and Metals Program

(millions of dollars)

Energy Efficiency – Transportation **$11.0**

Vehicle Efficiency
Personal Vehicles
Fleet Vehicles
Federal Vehicles Initiative
Canadian Lightweight Materials Research Initiative

Alternative Energy – Transportation **$17.0**

Fuel-Cell-Powered Mining Vehicles
Future Fuels Initiative
Ethanol Expansion Program
Biodiesel Initiative
Canadian Transportation Fuel Cell Alliance
Hydrogen Economy and Transportation Energy Program

Alternative Energy – Renewable Energy Sources **$23.1**

ENergy from the FORest (ENFOR)
Initiative to Purchase Electricity From Emerging Renewable Energy Sources
Photovoltaic and Hybrid Systems Program
RETScreen® International Clean Energy Decision Support Centre
Bioenergy Technology Program
Renewable Energy Deployment Initiative
Renewable Energy Technologies Program
Wind Power Production Incentive
Market Incentive Program

General Programs[1] **$10.7**

Outreach
National Energy Use Database

Total[2] **$155.62**

[1] Totals allocated for funding programs in Chapter 10 are reflected in the relevant program entries.
[2] Total does not add due to rounding.

Appendix 2: Data Presented in Report

The aggregate energy use data presented in this report are taken from Statistics Canada's *Report on Energy Supply–Demand in Canada* (RESD). Differences exist between this report and *Canada's Emissions Outlook: An Update* (CEO Update) concerning the sector allocations of RESD energy use data. The CEO Update's sector allocation is based on Environment Canada's *Trends in Canada's Greenhouse Gas Emissions 1990–1997*, whereas this report uses a definition better suited for the purpose of energy end-use analysis. Some modifications to the original Statistics Canada data were required and are documented in Appendix B of NRCan's *Energy Use Data Handbook, 1990 and 1995 to 2002.*

FIGURE 2-1: Canada: Changes in Energy Intensity and the Energy Efficiency Effect, 1990 to 2002

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Intensity Index	1.00	1.00	1.00	1.00	0.99	0.98	1.00	0.96	0.91	0.89	0.87	0.84	0.84
Index of Energy Efficiency Effect	1.00	0.98	0.97	0.95	0.94	0.92	0.94	0.91	0.90	0.89	0.88	0.87	0.87

FIGURE 2-2: Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Estimated energy use without energy efficiency improvements	1.00	1.00	1.02	1.07	1.11	1.15	1.17	1.20	1.19	1.24	1.29	1.27	1.31
Actual energy use	1.00	0.98	1.00	1.01	1.05	1.07	1.11	1.11	1.09	1.12	1.17	1.14	1.18

FIGURE 2-3: Electricity Production from Renewable Sources (GWh)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	3649	4134	4477	5362	5422	5855	6419	6599	7372	7418	7512

FIGURE 4-1: Canadian Households by Type of Dwelling, 2002

	Number of households	Percentage
Single detached	6 761 278	56
Apartments	3 753 855	31
Single attached	1 248 738	10
Mobile homes	257 138	2
Total	**12 021 009**	

FIGURE 4-2: Residential Energy Use by Purpose, 2002 (percent)

	Energy Use	Percentage
Space heating	830.8	59
Water heating	303.4	22
Appliances	181.5	13
Lighting	61.5	4
Space cooling	22.1	2
Total	**1399.4**	

FIGURE 4-3: Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Estimated energy use without energy efficiency improvements	1.00	1.04	1.10	1.14	1.15	1.17	1.23	1.21	1.13	1.18	1.25	1.22	1.28
Actual energy use	1.00	0.98	1.01	1.04	1.07	1.05	1.13	1.08	0.99	1.03	1.08	1.04	1.09

FIGURE 4-4: EnerGuide Rating for Houses Annual Heating Consumption for Houses Constructed to Different Standards

Description	EnerGuide for Houses Annual Heating Consumption (MJ)
Typical house built to R-2000 Standard	78 747
House built to Model National Energy Code (2002)	112 101
Typical new house (2002)	146 274
Typical existing house (1970)	216 812

Figure 4-5: Average Energy Consumption per Household, Pre-1946 to 2000–2004

Year Built	Average Energy (GJ) Consumption	EGH Rating
Pre–1946	295	45
1946–1960	220	58
1961–1970	211	61
1971–1980	202	63
1981–1990	191	66
1991–2000	167	70
2001–2004	156	73
All EGH in Canada	216	60
R-2000	100	82

FIGURE 4-6: Number of Eligible R-2000 Housing Starts, 1990 to 2003

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Number of R-2000 Houses	495	699	1196	1299	783	611	416	484	265	213	316	320	419	378

FIGURE 4-7: National Trends in Air Leakage (R-2000 and EnerGuide for Houses), Pre-1945 to 2000–2004

Year Built	First EGH Evaluation (A)	Post-Retrofit Evaluation (B)	R-2000
Pre–1945	12	9	n.a.
1945–1959	9	7	n.a.
1960–1969	7	6	n.a.
1970–1979	7	6	n.a.
1980–1989	6	6	0.9
1990–1999	4	4	1.1
2000–2004	3	3	1.1
Average	8	7	1.1

FIGURE 4-8: Evaluations Under EnerGuide for Houses, 1998–1999 to 2003–2004

Year of EGH Evaluation	1998–1999	1999–2000	2000–2001	2001–2002	2002–2003	2003–2004
Houses evaluated but not re-evaluated (A evaluation)	3675	9111	11 510	11 088	16 564	48 260
Houses evaluated and retrofitted (B evaluation)	832	226	607	709	1153	2724

FIGURE 4-9: Residential Energy Use and Energy Savings per Household*, Pre-1945 to 2000–2004

	Pre–1945	1945–1959	1960–1969	1970–1979	1980–1989	1990–1999	2000–2004	Average
Energy use pre-evaluation	295	220	211	202	191	167	156	216
Evaluation-identified energy savings	122	83	74	67	54	29	19	74
Actual energy savings after renovations	75	52	46	45	40	33	35	51

* Gigajoules

FIGURE 4-10: Eighth Amendment: Estimated Reductions in CO_2 Emissions, 2005 to 2020

	2005	2010	2015	2020
Residential GHG Savings (Mt)	0.17	1.22	2.46	3.44

FIGURE 4-12: Average Energy Consumption of New Appliances, 1990 and 2002 Models

	1990	2002
Clothes washers	1218	779.24
Clothes dryers	1103	915.62
Refrigerators	956	506.27
Dishwashers	1026	592.04
Ranges	772	755.98
Freezers	714	367.66

FIGURE 4-14: Impact of EnerGuide Labelling: Total Energy Savings and GHG Emissions Reductions Attributable to the EnerGuide for Equipment Program, 1990 to 2000

Year	Total energy savings (GWh)	GHG reductions (kt CO_2E)
1990	16.4	8.9
1991	21.7	11.8
1992	40.1	21.7
1993	41.9	22.6
1994	43.2	23.4
1995	40.3	21.8
1996	43.7	23.7
1997	46.7	25.3
1998	62.4	33.8
1999	83.8	45.4
2000	91.1	49.3
Cumulative annual	**531.3**	**287.7**

FIGURE 5-1: Commercial/ Institutional Energy Use by Building Type*, 2002

	Energy Use	Percentage
Office	382.2	34
Retail organization	237.1	21
Health care institution	104.6	9
Hotel and restaurant	85.9	8
School	95.3	8
Recreational facility	70.5	6
Warehouse	70.2	6
Other institution	60.4	5
Religious institution	16.1	1
Total	**1 122.3**	

* Excludes street lighting

FIGURE 5-2: Commercial/Institutional Energy Use by Purpose*, 2002

End Use	Energy Use	Percentage
Space heating	604.59	54
Lighting	150.98	13
Auxilary motor	122.12	11
Auxilary equipment	99.65	9
Water heating	78.27	7
Space cooling	66.73	6
Total	**1122.34**	

* Excludes street lighting

FIGURE 5-3: Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Estimated energy use without energy efficiency improvements	1.00	1.05	1.09	1.13	1.14	1.16	1.19	1.19	1.15	1.20	1.29	1.29	1.38
Actual energy use	1.00	1.03	1.04	1.08	1.07	1.11	1.13	1.15	1.09	1.13	1.24	1.22	1.30

FIGURE 5-4: Energy Use in Commercial Buildings, 2000

	Megajoules per m^2 per year
All buildings **	1590
New buildings*, **	1330
Model National Energy Code	1460
CBIP results	950
C-2000 projects	730

* 1990-2000

** Source: Commerical and Institutional Building Energy Use Survey, 2000. Estimates relate only to the surveyed area of populations over 175 000, and in Atlantic Canada to populations over 50 000.

FIGURE 5-5: Estimated Average GHG Reductions by Institution Under CBIP, 2003 to 2004

Building type	Number	Annual GHG Savings* (tonnes/year)	Average GHG savings (tonnes/year) 2004
Education	121	33 106	321
Health	57	12 252	272
Retail	36	6 735	217
Office	74	11 159	151
Multi-unit residential building	23	2 882	152
Other	61	11 681	225
Total	**372**	**77 814**	

* for average size building

FIGURE 5-6: Energy Innovators Initiative – Incentive Projects, 1998 to 2004

	Millions of dollars
Federal incentive	30.5
Client investment	561.0
Annual energy cost savings	80.0

FIGURE 5-7: Eighth Amendment: Estimated Reduction in CO_2 Emissions, 2005 to 2020

	2005	2010	2015	2020
Commercial CO_2 Savings (Mt)	0.02	0.07	0.12	0.17

FIGURE 6-1: Industrial Energy Use by Sub-sector, 2002

	Percent of Industrial Energy Use
Forestry	0.5
Construction	1.7
Cement	2.1
Chemicals	6.5
Iron and steel	7.5
Smelting and refining	8.1
Petroleum refining	11.5
Mining	17.7
Other manufacturing	17.8
Pulp and paper	26.7

FIGURE 6-2: Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2002

Industry	Energy Cost/ Total Production Cost
Cement	39.09
Chemicals	14.08
Pulp and paper	17.75
Aluminum	11.77
Iron and steel	11.91
Petroleum refining	2.02
Transportation equipment manufacturing	0.81

FIGURE 6-3: Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002

	1990	1995	1996	1997	1998	1999	2000	2001	2002
Estimated energy use without energy efficiency improvements	1.00	1.15	1.16	1.20	1.20	1.25	1.30	1.27	1.31
Actual energy use	1.00	1.07	1.10	1.10	1.08	1.12	1.15	1.10	1.17

FIGURE 6-4: CIPEC Energy Intensity Index, 1990–2002

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Energy Intensity Index	1.00	1.05	1.08	1.06	1.06	1.04	1.03	0.98	0.96	0.95	0.92	0.91	0.92

FIGURE 6-5: Industrial Energy Innovators, 1995–1996 to 2003–2004

	1995–1996	1996–1997	1997–1998	1998–1999	1999–2000	2000–2001	2001–2002	2002–2003	2003–2004
Number of Industrial Energy Innovators	176	203	208	212	227	280	305	382	529

FIGURE 7-1: Transportation Energy Use by Mode, 2002

	Energy Use	Percentage
Passenger light vehicle	1037.4	45
Freight truck	711.5	31
Passenger aviation	214.4	9
Freight marine	110.5	5
Off-road	91.3	4
Freight rail	71.4	3
Passenger bus	53.2	2
Freight aviation	13.7	1
Passenger rail	2.6	0
Total*	**2306**	

* Totals do not add due to rounding

FIGURE 7-2: Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2002

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Estimated energy use without energy efficiency improvements	1.00	0.97	0.99	1.03	1.10	1.13	1.15	1.20	1.24	1.28	1.30	1.30	1.32
Actual energy use	1.00	0.96	0.99	1.00	1.05	1.07	1.09	1.13	1.17	1.20	1.22	1.21	1.23

FIGURE 7-3: Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2002

	1990	1992	1994	1996	1998	2000	2002
Passenger car	72.9	71.7	66.6	62.1	58.4	61.6	63.2
Passenger light truck	27.1	28.3	33.4	37.9	41.6	38.4	36.8

FIGURE 7-4: New Car Fuel Efficiency, Normalized for Weight and Power, 1990 to 2001

Index 1990=1	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
L/100 km	1.00	1.00	1.01	0.99	1.00	0.99	0.97	0.98	0.96	0.99	0.97	0.96
L/100 km/kg	1.00	1.00	1.01	0.99	0.96	0.91	0.92	0.93	0.92	0.91	0.90	0.89
L/100 km/hp	1.00	0.98	0.95	0.93	0.91	0.85	0.82	0.82	0.79	0.79	0.76	0.75

FIGURE 7-6: Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards, 1990 to 2003

Truck Model Year	Truck Standard (11.4 L/100 km)	Trucks CAFC	Car Standard (8.6 L/100 km)	Cars CAFC
1990	11.8	11.4	8.6	8.2
1991	11.6	11.1	8.6	8.0
1992	11.6	11.3	8.6	8.1
1993	11.5	11.1	8.6	8.1
1994	11.5	11.5	8.6	8.2
1995	11.4	11.5	8.6	7.9
1996	11.4	11.3	8.6	7.9
1997	11.4	11.3	8.6	8.0
1998	11.4	11.4	8.6	7.9
1999	11.4	11.3	8.6	7.9
2000	11.4	11.1	8.6	7.7
2001	11.4	11.0	8.6	7.7
2002	11.4	11.1	8.6	7.8
2003	11.4	10.7	8.6	7.6

FIGURE 7-7: Vehicle Fuel Efficiency Awareness – EnerGuide Labels

Year	New vehicles on lot with EnerGuide label (%)	New vehicles in showroom with EnerGuide label (%)
1999	64	47
2001	77	56

Note: new data available in 2005

FIGURE 7-8: Vehicle Fuel Efficiency Awareness – AutoSmart

Year	Recollection of information on how to reduce vehicle fuel consumption (general public) (%)	Awareness of program activities (general public) (%)
1998	30	9
2002	36	16

FIGURE 7-9: Number of New Drivers Educated Using the AutoSmart Student Driving Kit, 1997–1998 to 2003–2004

Years	Number of new drivers educated
1997–1998	92 700
1998–1999	105 375
1999–2000	120 600
2000–2001	147 150
2001–2002	171 225
2002–2003	204 375
2003–2004	185 638

FIGURE 7-11: Drivers Trained and Participation in the Fleet Vehicle Program, 1997 to 2004

	Drivers Trained	FVP Members
1997–1999	51 100	346
1999–2000	53 100	1068
[illegible]	[illegible]	[illegible]
2001–2002	125 100	2707
2002–2003	149 100	2805
2003–2004	160 100	3257

FIGURE 8-1: Canadian Wind Power Capacity, 1990–2003

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Wind Power Capacity (MW)	0	0	0	19	19	20	20	21	24	124	137	214	230	327

FIGURE 9-1: GHG Emissions Reductions From Federal Operations, 1990–1991 to 2010–2011

	1990	1998	2000	2001	2002	2010 Target
GHG Emissions	3925	3164	3044	2973	2971	2704

FIGURE 9-2: Annual Energy Savings From the FBP, 1991–1992 to 2002–2003

	1991–1992	1992–1993	1993–1994	1994–1995	1995–1996	1996–1997	1997–1998	1998–1999	1999–2000	2000–2001	2001–2002	2002–2003
Annual additions	20	50	40	70	90	80	77	77	93	103	112	117
Annual cumulative	20	70	110	180	270	350	427	504	597	700	812	929

FIGURE 9-3: Federal Fleet Size and Fuel Consumption, 1995–1996 to 2002–2003

	1995–1996	1997–1998	1999–2000	2001–2002	2002–2003
Vehicles	24 854	22 796	22 462	23 313	26 233
Litres of gasoline equivalent (thousands)	88 725	75 684	78 281	63 300	68 619

FIGURE 9-4: Purchases of Alternative Fuel Vehicles for the Federal Fleet, 1997–1998 to 2003–2004

	1997–1998	1998–1999	1999–2000	2000–2001	2001–2002	2002–2003	2003–2004
Annual purchases	131	161	181	180	126	489	293

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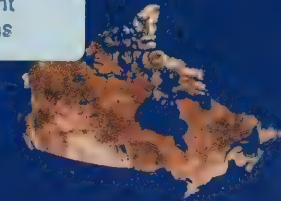

Improving Energy Performance in Canada

Report to Parliament Under the *Energy Efficiency Act*
For the Fiscal Year 2004–2005

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Published by the authority of the Minister of Natural Resources Canada
Government of Canada

Aussi disponible en français sous le titre :
Améliorer le rendement énergétique au Canada –
Rapport au Parlement en vertu de la *Loi sur l'efficacité énergétique*, Pour l'année financière 2004-2005

Cat. No. M141-10/2005E
ISBN 0-662-41243-5

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Her Excellency the Right Honourable Michaëlle Jean
C.C., C.M.M., C.O.M., C.D.
Governor General of Canada and Commander-in-Chief

Your Excellency,

I have the honour to present the *Report to Parliament Under the* Energy Efficiency Act for the fiscal year ending March 31, 2005, in accordance with Section 36 of the Act.

Respectfully submitted,

The Honourable John McCallum
Minister of National Revenue and
Acting Minister of Natural Resources Canada

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Figures

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Minister's Foreword

I am pleased to present the 12th Report to Parliament under the *Energy Efficiency Act*. This report outlines the many ways that Canada is boosting energy efficiency and increasing the use of renewable energy, as well as the key role the Government of Canada and Natural Resources Canada (NRCan) have played in achieving these results.

The past year has seen significant developments that reinforce the importance of energy efficiency. The Kyoto Protocol came into effect in February 2005 and, following that, the Government of Canada launched Project Green by releasing *Moving Forward on Climate Change: A Plan for Honouring our Kyoto Commitment*. Becoming more energy efficient is an underlying theme of our updated plan and one of the cornerstones of Canada's efforts to effectively address climate change. Recent supply disruptions caused by hurricanes in the Gulf of Mexico have also underlined the importance of using energy wisely and more efficiently.

As this report indicates, we have made progress in reducing energy use in every sector of our society, bringing economic, environmental and health benefits to Canadians. Increased energy efficiency has helped save money and fuel, bring down the greenhouse gas (GHG) emissions that contribute to climate change and improve air quality.

Here are a few examples that highlight the wide range of our successes from the fiscal year 2004-2005.

- Through the EnerGuide for Houses Retrofit Incentive program, more than 77 000 houses have been evaluated and labeled, leading to 17 000 grants totaling more than $10 million. After retrofits, home energy consumption was reduced by an average 27 percent, or 4 tonnes per year.

- The Government of Canada and the Canadian automobile industry signed a Memorandum of Understanding to reduce GHG emissions from light-duty vehicles by 5.3 megatonnes by 2010. This will be achieved through advanced technology and increased public education on energy-efficient driving techniques.

- The Government will invest an additional $920 million in the Wind Power Production Incentive over 15 years to increase the program's target to 4000 megawatts of wind-generated electricity.

- Efforts to educate and engage the public were intensified by bolstering programs such as ENERGY STAR® and EnerGuide labels and the One-Tonne Challenge, which calls on Canadians to reduce GHG emissions by 20 percent.

This is a small sample of the various programs and regulations NRCan supports to help governments, industry and individuals increase energy efficiency and reduce consumption. We are also involved in innovative research and development programs that are putting Canada at the forefront of developing clean and renewable energy technology.

Clearly, improved energy efficiency is a fundamental priority for the Government of Canada. As we search for ways to respond to climate change, I hope all Canadians will share this priority.

Through fresh perspectives, innovative approaches and creative ideas, we can strike the balance between economic prosperity and environmental well-being. We can build stronger, cleaner communities. I believe that this is our responsibility to the generations of Canadians that will follow in our footsteps.

John McCallum

The Honourable John McCallum
Minister of National Revenue and Acting Minister of Natural Resources Canada

Executive Summary

Canadians spend almost $129 billion per year on energy to heat and cool their homes and offices and to operate their appliances, cars and industrial processes. Several factors contribute to Canadian energy demand: a vast geography, a northern climate with extreme seasonal variations in temperature and an economy founded on an abundance of natural resources.

Types of Energy Use

There are two general types of energy use: primary and secondary. Primary use comprises Canada's total consumption, including energy required to transform one form to another – such as coal to electricity – and to deliver energy to consumers. Secondary use comprises energy consumed for residential, commercial/institutional, industrial, transportation and agricultural purposes.

Key highlights in energy use include the following:

- Between 1990 and 2003, the latest year for which figures are available, primary energy use increased by 24.0 percent.
- In 2003, secondary use accounted for 70.0 percent of primary energy use and produced 68.6 percent (502 megatonnes) of Canada's total greenhouse gas (GHG) emissions. This last figure includes emissions produced by utilities in meeting the demand for electricity.
- Without improvements in energy efficiency made to buildings and equipment and the changes in the behaviour of energy users during the past several decades, the increases in energy use would have been much higher.

The industrial sector consumes the most energy, accounting for 38.4 percent of total secondary energy use in 2003. Transportation is second (27.9 percent), followed by residential (17.2 percent), commercial/institutional (14.0 percent) and agriculture (2.5 percent).

Promoting Energy Efficiency

For the past decade, Natural Resources Canada (NRCan) has promoted energy efficiency and the use of alternative energy as a means to reduce GHG emissions and save money. NRCan exercises a broad range of policy instruments, including leadership, information, voluntary actions, financial incentives, research and development, and regulation.

The *Energy Efficiency Act*, which came into force in 1992, provides for the making and enforcement of regulations concerning minimum energy performance levels for energy-using products, as well as the labelling of energy-using products and the collection of data on energy use. The *Energy Efficiency Regulations* are described in Chapter 2.

Energy Intensity / Energy Efficiency

As explained in Chapter 1, although aggregate energy intensity is sometimes used as a proxy for energy efficiency, there is a difference between the two terms. Understanding this difference is important when comparing Canada with other countries. Energy intensity is a broader measure, capturing not only energy efficiency, but also the impacts of weather variations and changes in the structure of the economy (among other aspects). While Canada has a higher aggregate intensity than most International Energy Agency (IEA) countries, it has made significant overall improvements in energy efficiency. According to a recent IEA report[1] that examined 13 countries, Canada has the fourth fastest rate of energy efficiency improvement.

[1] International Energy Agency, *Oil Crises and Climate Challenges – 30 Years of Energy Use in IEA Countries*, Paris, 2004.

Evidence of Change

As explained in this report, recent growth in energy use is primarily due to increased activity in various sectors; however, this growth would have been far greater without improvements in energy efficiency. As reported in Chapter 1, energy efficiency improvements made between 1990 and 2003 are estimated to have reduced GHG emissions by almost 52.3 megatonnes and decreased energy expenditures by an average of $13.4 billion in 2003 alone.

Over this period, the residential sector recorded a 19.4 percent increase in energy efficiency. The figures for transportation (15.7 percent), industry (12.6 percent) and the commercial/institutional (1.1 percent) sectors demonstrate that improvements in energy efficiency are being made throughout the economy.

Through improvements in energy efficiency, Canadians can reduce the size of their energy bills and achieve important environmental goals. In the short term, changes to less GHG-intensive fuels (e.g. from coal to natural gas) can help reduce GHG emissions. However, over the long term, reducing GHG emissions further will require more widespread use of alternative energy.

In recent years, the production of energy derived from alternative sources has increased significantly. Between 1990 and 2001, the last year for which data are available, the amount of electricity generated from the sun, wind and biomass increased by 204 percent.

Engaging Canadians

To maximize the effectiveness of its initiatives, NRCan engages a growing number of partners from the private and public sectors. Dozens of cooperative agreements are in place with a broad range of businesses, community groups and other levels of government.

These initiatives engage Canadian society, along with every sector of the economy, in new and more efficient approaches to secondary energy use and in the development and deployment of renewable energy sources.

This report provides an overview of the work being done in each sector, highlights NRCan's efficiency and alternative energy (EAE) programs and lists their key achievements for 2004–2005. All programs are described in the corresponding sector chapter. Program entries for market transformation programs also include quantitative performance indicators in graph or table format (see below). A list of NRCan's EAE initiatives and expenditures appears in Appendix 1.

Performance Indicators Highlighted in the Report

Equipment

- Energy Efficiency Regulations Impact, 2010 and 2020
- Awareness Levels of ENERGY STAR® in Canada
- ENERGY STAR Qualified Appliances as a Percent of Total Category Sales in Canada, 2003

Housing

- Annual Heating Consumption for Houses Constructed to Different Standards
- Average Energy Consumption per Household, Pre-1946 to 2001–2004 Construction
- Average Energy Consumption of New Appliances, 1990 and 2003 Models
- Number of Eligible R-2000 Housing Starts, 1990 to 2004
- National Trends in Air Leakage, Pre-1945 to 2000–2004 Construction
- Evaluations Under EnerGuide for Houses, 1998–1999 to 2004–2005
- Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2004

Buildings

- Energy Use in Commercial Buildings
- Estimated Average GHG Reductions by Type of Institution Under the Commercial Building Incentive Program, 2004
- Energy Innovators Initiative – Incentive Projects, 1998 to 2005

Industry

- CIPEC Energy Intensity Index, 1990 to 2003
- Industrial Energy Innovators, 1995–1996 to 2004–2005

Transportation

- Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards, 1990 to 2004
- Vehicle Fuel Efficiency Awareness – EnerGuide Labels
- Vehicle Fuel Efficiency Awareness – Program Activities
- Drivers Trained and Participation in the Fleet Vehicle Program, 1997–1999 to 2003–2004

Renewable Energy

- Electricity Generation Capacity From Renewable Sources (Includes Hydro)
- REDI for Business Projects Completed, 1998–1999 to 2004–2005

Federal House in Order

- GHG Emissions Reductions From Federal Operations, 1990 to 2010
- Annual Energy Savings From the ETAG, 1991–1992 to 2004–2005
- Federal Fleet Size and Fuel Consumption, 1995–1996 to 2003–2004
- Purchase of Alternative Fuel Vehicles (Including Hybrids) for the Federal Fleet, 1997–1998 to 2004–2005

Introduction

Natural Resources Canada's Efficiency and Alternative Energy Program

Since the early 1990s, Natural Resources Canada (NRCan) has emphasized the promotion of energy efficiency and the use of alternative energy (i.e. alternative transportation fuels and renewable energy) as a means to reduce greenhouse gas (GHG) emissions.

Greenhouse Gases and Climate Change

Climate change is a global challenge arising from the continuing buildup in levels of anthropogenic (human-produced) GHGs in the atmosphere, in addition to naturally occurring emissions. GHGs are composed of a number of gases, and the main source of anthropogenic emissions is the combustion of fossil fuels. In December 1997, Canada and more than 160 other countries met in Kyoto, Japan, and agreed to targets to reduce GHG emissions. Canada's target is to reduce its GHG emissions to 6 percent below 1990 levels by the first commitment period (2008 to 2012). The Government of Canada ratified the Kyoto Protocol and notified the United Nations of its decision on December 17, 2002. With Russia's ratification on October 25, 2004, the Protocol came into force on February 16, 2005.

A complete list of NRCan's efficiency and alternative energy (EAE) initiatives in 2004–2005 is provided in Appendix 1. These initiatives engage Canadian society and all major sectors of the economy in new and more advanced approaches to secondary energy use – i.e. to the consumption of energy in the residential, commercial/institutional, industrial and transportation sectors.

NRCan's EAE initiatives are managed by

- the Office of Energy Efficiency, which delivers market transformation initiatives to improve energy efficiency and the use of alternative transportation fuels
- the CANMET[1] Energy Technology Centre and the Mineral Technology Branch, which deliver EAE research and development (R&D) initiatives
- the Electricity Resources Branch, which delivers market transformation initiatives for renewable energy
- the Science Branch of the Canadian Forest Service, which undertakes R&D in the use of forest biomass for energy

In its efforts to reduce GHG emissions, NRCan emphasizes partnership and cooperation with stakeholders, such as other levels of government, the private sector and non-governmental organizations. Using this approach, the demand side of the energy market moves toward more energy-efficient capital stock, production processes and operating practices without reducing service or comfort levels. On the supply side, Canada participates in developing technology for tapping renewable energy resources and alternative transportation fuels as well as for increasing the energy efficiency of energy production.

[1] CANMET is the Canada Centre for Mineral and Energy Technology.

Policy Instruments

NRCan's key policy instruments are as follows:

- regulation
- financial incentives
- leadership
- information
- voluntary initiatives
- research and development

Figure 1 shows how these policy tools work together to increase energy efficiency, i.e. how they help to reduce the amount of energy needed to obtain a certain level of service. R&D increases the opportunities for achieving greater levels of efficiency in a particular type of energy use. Non-R&D measures increase the take-up of existing opportunities to use energy more efficiently. Energy performance regulations eliminate less efficient products from the market.

Regulation

The *Energy Efficiency Act* gives the Government of Canada the authority to make and enforce regulations, primarily to establish performance and labelling requirements for energy-using products, doors and windows that are imported or shipped across provincial or territorial borders.

Financial Incentives

NRCan uses financial incentives to encourage final users of energy to employ energy efficiency and renewable energy technologies and practices. NRCan also offers financial incentives for wind energy, ethanol plants and for natural gas vehicles and refuelling infrastructure.

Leadership

Leadership means setting an example for other levels of government and for the private sector by increasing energy efficiency and the use of alternative energy in the Government of Canada's operations.

Information

NRCan disseminates information to consumers, using methods that range from broad distribution to individual consultations with clients, to increase awareness of the environmental impact of energy use and to encourage consumers to become more energy efficient and to make greater use of alternative energy sources. Activities include publications, exhibits, advertising, toll-free lines, conferences, Web sites, workshops, training, building-design software and promotional products.

Voluntary Initiatives

Companies and institutions work with NRCan on a voluntary basis to establish and achieve energy efficiency objectives. NRCan's voluntary EAE initiatives target large consumers of energy in the commercial/institutional and industrial sectors and organizations whose products are important determinants of energy use. The initiatives involve industry-government agreements and, for groups of large industrial energy users, energy efficiency target setting. NRCan provides a variety of support services to assist and stimulate action by companies and institutions on energy efficiency, including developing standards and training.

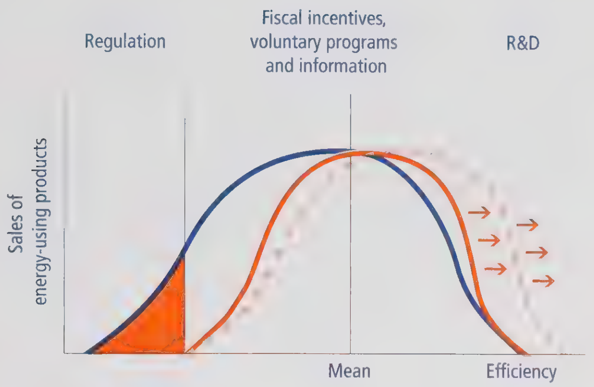
Research and Development

NRCan's EAE initiatives support the development and dissemination of more energy-efficient equipment, processes and technologies and alternative energy technologies. R&D also provides the scientific knowledge needed to develop the technologies, codes, standards and regulations required for the sustainable use of energy.

NRCan provides national leadership in energy science and technology (S&T) by undertaking in-house research in its own laboratories, by contracting out research activities to other organizations and through the federal funding initiatives listed in Chapter 9, which are the only federal interdepartmental S&T investment funds that focus on the energy sector and its economic and environmental effects.

FIGURE 1

Moving the Market



Measuring Progress

The primary goal of NRCan's EAE initiatives is to change energy consumption patterns to obtain environmental and economic benefits. Part of assessing program progress and performance involves considering both program delivery and program effectiveness.

In the past, NRCan has focused on the monitoring and tracking of the following three aspects of program delivery:

- program outputs
- program outcomes
- market outcomes

Program outputs are the items produced regularly, such as information and marketing materials, demonstration projects, financial incentives and regulations. Program outputs are designed to lead to **program outcomes** – namely, changes in the behaviour of groups targeted by a program. These groups may be either energy users or producers of energy-using equipment or structures. For example, program outcomes occur when consumers purchase more energy-efficient appliances than they would have if there were no program. Other important factors that influence consumer behaviour include product price, household income, personal taste and other government and non-government programs.

Since program outcomes can directly affect the amount and type of energy consumed in the market, they contribute, in part, to observable **market outcomes**. Market outcomes ultimately reflect the impacts of NRCan programs on changes in energy efficiency, energy intensity, GHG emissions and the use of alternative energy. In this sense, achievement of a targeted market outcome, or observable progress towards a market outcome, serves as an indicator of program effectiveness. An example of a program outcome that leads to a market outcome is a householder's purchase of a more energy-efficient appliance and reduced use of electricity. Depending on the source of electricity and how the utility changes its electricity-generating methods to meet the change in demand that results from reduced electricity use, this could also lead to a decline in GHG emissions.

In This Report

This twelfth annual Report to Parliament focuses principally on EAE initiatives that address secondary energy use. Trends in energy use and GHG emissions in Canada are discussed in Chapter 1. Chapter 2 discusses the equipment regulations under the *Energy Efficiency Act* and equipment labelling activities. Chapters 3 to 6 review individual EAE initiatives to improve energy use in housing, buildings, industry and transportation, highlighting their achievements and progress indicators. Chapter 7 deals with renewable energy sources and use. Chapter 8 describes the Government of Canada's actions to improve its own use of energy. Chapter 9 describes general programs not specific to EAE initiatives discussed in Chapters 3 to 7. The final chapter describes domestic and international cooperation in EAE. Appendix 1 contains information on NRCan's EAE expenditures. Appendix 2 contains detailed information on the data presented in this report.

Chapter 1: Trends in Energy Use

Introduction

Canadians enjoy an abundance of energy from a variety of sources. This comparative advantage in the supply of energy helps Canadians deal with the economic disadvantages of small domestic markets, long distances, rugged geography and a relatively harsh climate. It also has favoured the development of industries that have a particularly strong energy demand.

Canadians spend almost $129 billion per year on energy to heat and cool their homes and offices and to operate their appliances, cars and industrial processes. This represents about 13 percent of the country's gross domestic product (GDP).

Energy Use and Greenhouse Gas Emissions

There are two general types of energy use: primary and secondary. Primary energy use encompasses the total requirements for all users of energy, the energy required to transform one energy form to another (e.g. coal to electricity) and the energy used to bring energy supplies to the consumer. Secondary energy use is energy used by final consumers for residential, commercial/institutional, industrial, transportation and agricultural purposes.

Primary energy use in Canada today reflects changes over several decades in energy-consuming equipment and buildings and in the behaviour of energy users. Primary energy use increased by 24.0 percent between 1990 and 2003, from 9743 petajoules to 12 081 petajoules.

Secondary energy use (8457 petajoules) accounted for 70.0 percent of primary energy use in 2003. It was responsible for 68.6 percent (502 megatonnes) of total greenhouse gas (GHG) emissions in Canada, if indirect emissions – namely, those produced by electric utilities to meet end-use electrical demand – are included.

This report deals with energy-related GHG emissions, which comprise carbon dioxide (CO_2), methane and nitrous oxide. CO_2 represents the majority of Canada's GHG emissions. All subsequent references in this report to CO_2 and GHGs include emissions that are attributable directly to secondary energy use and indirect emissions attributable to electricity generation, unless otherwise specified.

From 1990 to 2003, secondary energy use increased by 21.7 percent and related GHG emissions increased by 23.0 percent. The GHG intensity of energy changed slightly during the period as fuel switching towards less GHG-intensive fuels offset a higher GHG intensity in electricity production. The industrial sector is the largest energy user, accounting for 38.4 percent of total secondary energy use in 2003. The transportation sector is the second largest energy user at 27.9 percent, followed by the residential sector at 17.2 percent, the commercial/institutional sector at 14.0 percent and the agriculture sector at 2.5 percent.

Energy Intensity / Energy Efficiency

Aggregate energy intensity is the ratio of energy use per unit of GDP or, alternatively, energy use per capita. Aggregate energy intensity is sometimes used as a proxy for energy efficiency because it is simple, straightforward and the data for the calculation are readily available.

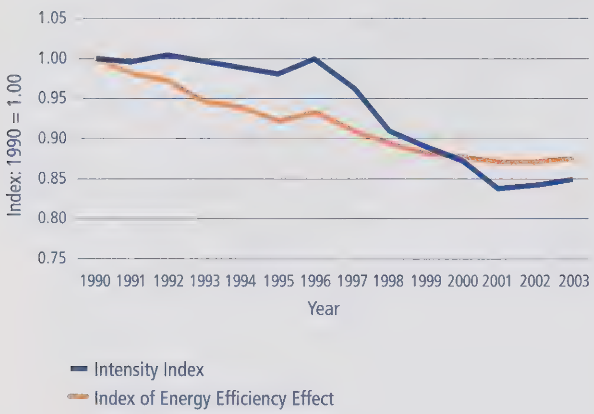
However this measure is misleading because, in addition to pure energy efficiency, intensity captures the impacts of weather variations and changes in the structure of the economy, among other things.

To properly gauge changes in energy efficiency over time, differences in economic structure and weather need to be normalized or factored out of the intensity calculation. Natural Resources Canada's (NRCan's) Office of Energy Efficiency (OEE) applies an internationally recognized factorization analysis technique to isolate the impact of energy efficiency on changes in Canadian energy use.

Figure 1-1 compares, for Canada, an index of annual variation in energy intensity with the OEE's index of changes in energy efficiency over the period 1990 to 2003. The indexes present improvements in energy intensity and efficiency as a downward trend.

FIGURE 1-1

Canada: Changes in Energy Intensity and the Energy Efficiency Effect, 1990 to 2003



International Comparisons

Canada has a higher aggregate intensity – absolute energy use per capita or per unit of GDP – than most International Energy Agency (IEA) countries, ranking second and fourth, respectively.

Meaningful comparisons of energy efficiency between countries can be difficult because very detailed energy, equipment stock, production and/or weather data for each target country are required.

However, according to a recent IEA report entitled *Oil Crises and Climate Challenges – 30 Years of Energy Use in IEA Countries*, Canada's energy efficiency improved at an average annual rate of 1 percent between 1990 and 1998, similar to the rate recorded by the United States, and the fourth fastest rate of improvement among the 13 countries included in the report (surpassed by Finland, Italy and Norway).

TABLE 1-1

Energy Intensities for Selected IEA Countries, 2002

	GJ* per capita		GJ per $1,000 of GDP
Luxembourg	357.3	Czech Republic	17.9
Canada	253.9	Hungary	12.8
United States	226.8	Turkey	11.5
Finland	210.5	Canada	10.6
Norway	190.1	Korea	8.5
Belgium	166.1	New Zealand	8.2
Sweden	164.7	United States	7.1
Netherlands	155.6	Portugal	6.6
New Zealand	154.4	Finland	6.5
Australia	150.0	Australia	6.2

*Gigajoules

GDP is in 1995 US$ converted at exchange rate

Trends in Energy Efficiency

NRCan annually publishes *Energy Efficiency Trends in Canada*, which reports on changes in energy use (and GHG emissions) and the contribution of the following key factors to these changes:

- Increases in sector **activity** lead to increased energy use and emissions. In the residential sector, for example, an increase in the number of households results in increased energy use.
- Fluctuations in **weather** lead to changes in space-heating and space-cooling requirements. A colder winter or a warmer summer can lead to increased energy use.
- A shift in the **structure** of activity toward more energy-intensive components of activity leads to increased energy use and emissions. For example, if the distribution of activity in the industrial sector shifts from forestry to the iron and steel industry, industrial energy use will increase because the former sector is less energy intensive than the latter.
- A higher **service level** for auxiliary equipment (e.g. computers, fax machines and photocopiers) increased energy use and emissions. This factor is only applied to commercial/institutional buildings. During the 1990s, these types of equipment were widely adopted; however, improvements in functionality increased productivity and moderated increases in energy consumption due to the use of more machines.
- **Energy efficiency** refers to how effectively energy is being used, for example, how long an appliance can be operated with a given amount of energy.

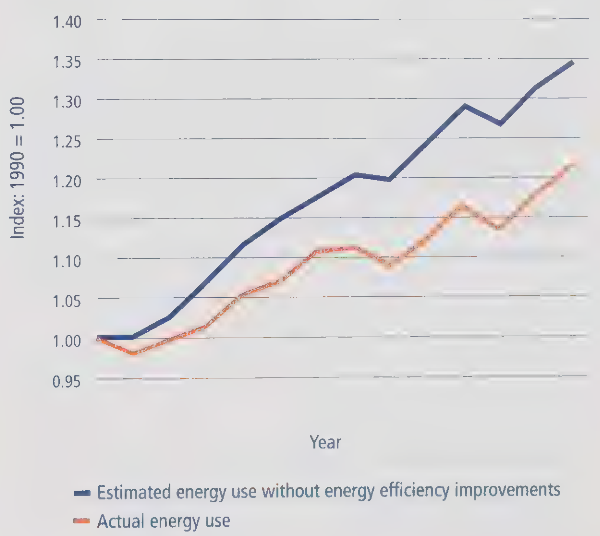
In this report, changes in energy efficiency are the net result after allowing for the changes in energy use due to changes in activity, weather, structure and service level. To the extent that other factors that affect energy use have not been captured, this measure of energy efficiency improvement might overstate or understate the "actual" change. For example, in the industrial sector, in an industry such as other manufacturing, there may have been changes in energy use due to shifts in the mix of products, but this is not captured.

Secondary energy use increased between 1990 and 2003 (from 6951 to 8457 petajoules). Without improvements in energy efficiency, increases attributable to activity, weather, structure and service level would have led to an increase in secondary energy use of 34.4 percent. However, as a result of a 12.7 percent (883 petajoules) improvement in energy efficiency, actual secondary energy use increased by 21.7 percent (8457 petajoules).

The change in energy use between 1990 and 2003, actual and without energy efficiency improvements, is shown in Figure 1-2. The difference in energy use due to energy efficiency – the estimated energy saving – represents a reduction in energy costs of $13.4 billion in 2003 and a reduction in GHG emissions of more than 52 megatonnes. Changes in energy efficiency are estimated for each of the four major end-use sectors and are presented in Chapters 3 to 6. The energy efficiency improvements were largest in the residential sector (19.4 percent), followed by the transportation sector (15.7 percent), industrial sector (12.6 percent), and commercial/institutional sector (1.1 percent).[1]

FIGURE 1-2

Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003



[1] The aggregate energy-use data presented in this report are taken from Statistics Canada's *Report on Energy Supply-Demand in Canada* (RESD). Differences exist between this report and *Canada's Emissions Outlook: An Update* (CEO Update) concerning the sector allocations of RESD energy use data. The CEO Update's sector allocation is based on Environment Canada's *Trends in Canada's Greenhouse Gas Emissions 1990–1997*, whereas this report uses a definition better suited for energy end-use analysis. Some modifications to the original Statistics Canada data were required and are documented in Appendix A of Natural Resources Canada's *Energy Use Data Handbook, 1990 and 1997 to 2003.*

TABLE 1-2

Explanation of Changes in Secondary Energy Use, 1990 to 2003

	Sectors					
	Residential	Commercial/ Institutional	Industrial	Transportation	Total*	% Change
1990 energy use (PJ)	1289.3	867.0	2717.4	1877.9	6950.8	
2003 energy use (PJ)	1457.6	1180.9	3245.7	2361.3	8457.3	
Change in energy use (PJ)	168.2	313.9	528.3	483.4	1506.5	21.7%
Explanatory factor (change due to)						
Activity	331.8	223.0	1209.6	592.0	2356.5	33.9%
Weather	42.4	28.9	n/a	n/a	71.3	1.0%
Structure	44.5	0.6	-337.7	144.4	-148.2	-2.1%
Service level	n/a	70.9	n/a	n/a	70.9	1.0%
Energy efficiency	-250.5	-9.6	-343.6	-279.6	-883.3	-12.7%
Other factors		0.1		26.6	39.4	0.6%

*Total also includes energy use for agriculture (not shown in table)

Trends in Renewable Energy

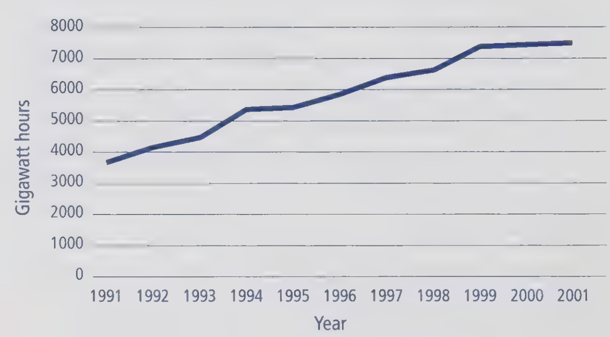
As previously noted, changes in the fuel mix employed by the Canadian economy can reduce GHG intensity. Although in the near term this can be achieved by moving from more to less GHG-intensive fuels (e.g. from coal to natural gas), over the longer term the use of renewable energy sources is expected to accelerate this trend.

Figure 1-3 shows the trend in the use in Canada of electricity generated from wind, solar and biomass, indicating a 204 percent increase over 1991–2001. Although representing only a small component of overall electricity use, the proportion of electricity generated from these renewable energy sources increased from 0.75 percent to 1.32 percent over the period, representing a 57 percent increase in its share. Most of this production was derived from biomass.

The graph does not include hydro sources, either conventional or small (less than 20 megawatts). The former accounts for about 60 percent of electricity generated in Canada; installed capacity is over 62 gigawatts. There are over 230 small hydro installations in Canada, with a total capacity of about 1500 megawatts.

FIGURE 1-3

Electricity Production From Renewable Sources (GWh), 1991 to 2001



Chapter 2: Equipment, Standards and Labelling

Introduction

Among Natural Resources Canada's (NRCan's) wide range of energy efficiency initiatives are Canada's *Energy Efficiency Regulations*, standards and labelling programs.

The *Energy Efficiency Act*, which came into force in 1992, gives the Government of Canada the authority to make and enforce regulations about performance and labelling requirements for energy-using products that are imported into Canada or shipped across provincial or territorial borders.

Following extensive consultations with provincial governments, affected industries, utilities, environmental groups and others, the first *Energy Efficiency Regulations* came into effect in February 1995. The Regulations refer to national consensus performance standards developed by the Canadian Standards Association, which include testing procedures that must be used to determine a product's energy performance. Regulated products that fail to meet the minimum performance levels identified by the Regulations cannot be imported into Canada or traded interprovincially.

Through the Accelerated Standards Action Program, NRCan works with key stakeholders to improve the standards development and approval processes and accelerate the market penetration of high-efficiency residential, commercial and industrial equipment.

Regulations have now been established for more than 30 products that consume 80 percent of the energy used in the residential sector in Canada and 50 percent of the energy used in the commercial/institutional sector. Regulated products include major household appliances, water heaters, heating and air-conditioning equipment, automatic icemakers, dehumidifiers, dry-type transformers, electric motors of 1 to 200 horsepower and certain lighting products. The Regulations continue to apply to these products even if they are incorporated into a larger unit or machine that is not regulated.

NRCan regularly amends the Regulations to strengthen the minimum energy performance requirements for prescribed products where the market has been transformed to a higher level of efficiency. The Regulations are also amended occasionally to add new products, harmonize minimum energy performance requirements with those of other jurisdictions and update testing methodologies or labelling requirements. Finally, regulations may be established for gathering market data on the energy performance of certain types of equipment. For gas fireplaces, for example, the data gathered is used to support programs developed by the industry and NRCan and its partners for gas fireplace performance.

Before adding a new product or otherwise amending the Regulations, NRCan conducts studies to analyse how the proposed change will affect the market (e.g. will it have a measurable impact on energy efficiency levels without imposing undue hardship on manufacturers). A key criterion for amending the Regulations is that the change must have a significant positive impact on consumers and the environment. Stakeholders are consulted on all proposed changes to the Act and Regulations, as well as on their practical application in the marketplace.

Canada's *Energy Efficiency Act* and *Energy Efficiency Regulations* support a number of labelling initiatives that aim to help consumers and commercial/industrial procurement officials identify and purchase energy-efficient equipment that will save them money and reduce greenhouse gas emissions over the life of the product.

For example, the Act and the Regulations require that an EnerGuide label be displayed on major electrical household appliances and room air conditioners. For appliances, the EnerGuide label shows the consumer the estimated annual energy consumption of the product in kilowatt hours and compares it with the most- and least-efficient models of the same class and size. Labels for room air conditioners indicate the model's energy efficiency ratio and provide a comparative bar scale.

The EnerGuide label is also used voluntarily by manufacturers and suppliers of residential oil and gas furnaces, vented gas fireplaces, central air conditioners and air-to-air heat pumps. In this case, the EnerGuide rating for a specific product (annual fuel utilization efficiency rating for oil and gas furnaces, fireplace efficiency rating for gas fireplaces and seasonal energy efficiency ratio for central air conditioners) is published on the back page of the manufacturer's brochure and includes a bar scale that allows consumers to compare the model with others of the same size and capacity.

The EnerGuide for Industry Program uses the EnerGuide name to encourage the use of more energy-efficient off-the-shelf industrial equipment, including equipment that is prescribed under Canada's *Energy Efficiency Regulations*. This equipment includes electric motors; dry-type transformers; heating, cooling and ventilation equipment; and certain lighting products. EnerGuide for Industry offers up-to-date product databases, Web-based applications and energy-use information that enable equipment buyers to compare the energy performance of various products and select the most energy-efficient model that meets their needs.

As well, the Regulations are consistent with and build on the ENERGY STAR® initiative in Canada. The internationally recognized ENERGY STAR symbol is a simple way for consumers to identify products that are among the most energy efficient on the market. Products prescribed in the Regulations that are also part of the ENERGY STAR initiative must meet levels of energy efficiency starting at 10 percent or more than the minimum performance levels set out in the Regulations in order to qualify for the ENERGY STAR symbol. As higher-performance products penetrate the market, ultimately their efficiencies become candidate standard levels.

Standards

As a world leader in the use of energy efficiency standards, NRCan is committed to harmonizing federal standards and labelling requirements with those developed in other jurisdictions. Harmonization reduces barriers to trade and sustainable development by improving the flow of energy-efficient products within Canada and around the world, minimizes the regulatory burden on manufacturers, and avoids confusion for consumers.

For instance, the performance requirements in Canada's *Energy Efficiency Regulations* are similar to those in several Canadian provinces that regulate energy-using equipment manufactured and sold within their borders. Although NRCan works closely with these provinces to ensure maximum harmonization of standards, in some cases provincial regulations may differ from the federal requirements or may apply to other types of energy-using equipment.

Due to the highly integrated North American market, Canada's energy performance requirements for many products are also similar to those regulated in the United States. As well, Canada's EnerGuide labelling requirements are coordinated with the U.S. EnergyGuide labelling program. Harmonization work is also undertaken through the North American Energy Working Group, which involves Canada, the United States and Mexico.

The Asia-Pacific Economic Cooperation (APEC) organization is another important forum for regional cooperation on harmonization issues. Trade and investment liberalization and facilitation are high on the agenda of the APEC Energy Working Group (EWG). Among other initiatives, the EWG has been endeavouring to harmonize energy efficiency test methods and conformity assessment regimes of Asia-Pacific economies that use energy efficiency standards and labels as part of their environmental or energy programs.

NRCan also supports Canadian representation on committees of the International Organization for Standardization and the International Electrotechnical Commission, as well as the national and international policy work of the Standards Council of Canada.

Compliance and Enforcement

The *Energy Efficiency Regulations* outline a number of responsibilities for dealers who import to Canada, or ship from one Canadian province to another, any prescribed energy-using product. NRCan is committed to securing voluntary compliance but can use a range of enforcement measures, when necessary.

NRCan emphasizes self-monitoring, reporting, voluntary compliance and collaboration. However, the *Energy Efficiency Act* prescribes enforcement measures that can be used if dealers violate the law. Enforcement

activities include preventing products that do not meet the prescribed energy efficiency standard from entering Canada; preventing the sale or lease of non-compliant products in Canada; and fines. Violators can also be fined under the Canada Border Services Agency's (CBSA's) Administrative Monetary Penalty System for not providing required information on the prescribed product at the time of import; serious violations can be prosecuted.

To monitor compliance with the Regulations, NRCan captures information originating from two sources: energy efficiency reports and the import documents. Section 5 of the *Energy Efficiency Act* requires that dealers provide energy efficiency reports when they first market a new product model. They provide NRCan with such information as the energy performance of each particular model, the name of the testing agency, the size category and other facts, as described in Schedule IV of the Regulations.

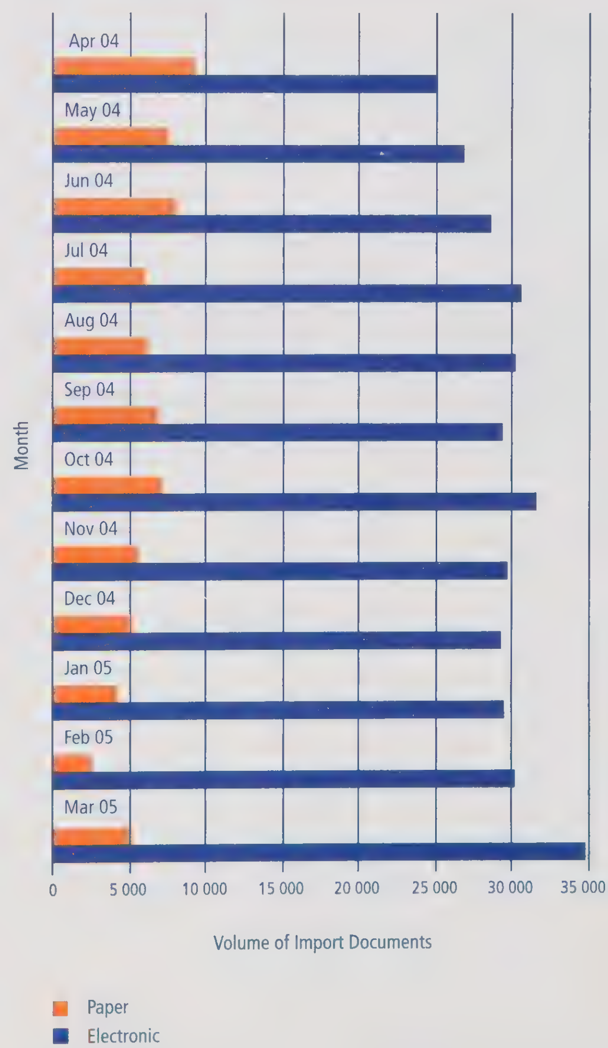
The Regulations require that when importing a regulated product to Canada, dealers must provide, on customs documents for CBSA officers, specific product information (type of product, brand name, model number, name and address of dealer and purpose of import) on all shipments. Customs documents contain much less information than the energy efficiency report, but there is enough to allow NRCan to verify that there is a matching energy efficiency report. NRCan is then in a position to verify that all products that enter Canada meet the required energy performance levels and to take action when necessary.

Key 2004–2005 Achievements

- NRCan processed over 388 000 records (records from April 1, 2004, to February 28, 2005) relating to the importation of regulated energy-using products to Canada in 2004–2005. The graph below illustrates the volume of import documents received in paper and electronically per month over the 2004–2005 fiscal year.
- Over 127 000 new or revised model numbers were submitted to NRCan for entry into NRCan's equipment database (records from April 1, 2004, to March 21, 2005) from energy efficiency reports received from dealers.
- The processes for submitting the required energy efficiency reports were improved, thereby making it easier to update and process greater amounts of data in the database. This will have a positive effect on the system's monitoring capabilities.
- New reporting forms were developed for energy-using products added to the Regulations.
- Fact sheets and electronic bulletins were distributed to dealer, manufacturer and importer communities about new regulations on exit signs, chillers and dry-type transformers and the coming into force of Amendment 8 to the Regulations. Other communications included notices to stakeholders reminding them of the requirements of the Regulations. Instances of non-compliance were handled on a case-by-case basis in accordance with the Compliance Policy.

FIGURE 2-1

Monthly Import Volumes



Regulatory Impact to Date per Regulatory Impact Analysis Statement

In preparing amendments to the Regulations, NRCan analyses the impact of the proposed amendment on society, the economy and the environment. This information is made available through the Regulatory Impact Analysis Statement, which is annexed to the Regulations and published in the *Canada Gazette Part II.*

As a result of Canada's minimum energy performance standards, it is estimated that an aggregate annual emissions reduction of 25.6 megatonnes will be achieved by 2010. This is equivalent to taking 4 million cars off the road. The net benefit to consumers from just the latest amendment that prescribes new standards for clothes washers, water heaters, chillers and exit signs is estimated to be $47 million by 2010. These benefits will continue to grow throughout the lifetime of the machines, which in some cases is 25 years.

TABLE 2-1

Energy Efficiency Regulations Impact (Aggregate Annual Savings)

Products (Amendment in brackets)	*Energy Savings (PJ)*		*CO_2 Reductions (Mt)*	
	2010	*2020*	*2010*	*2020*
Residential appliances	117.20	133.84	13.26	15.60
Lamps (fluorescent/incandescent)	11.60	13.40	7.55	9.80
Motors	16.30	17.70	2.03	2.14
Commercial HVAC	6.40	7.50	0.43	0.57
Refrigerators (5)	4.92	10.96	0.49*	1.10*
Ballast/room A/C, PAR lamps (6)	3.96	9.44	0.39*	0.94*
Clothes washers, domestic hot water, exit signs, chillers (8)	16.20	42.67	1.29	3.61
A/C, commercial refrigeration (draft 9)	1.57	5.35	0.16	0.53
Total	**178.15**	**240.86**	**25.60**	**34.29**

*Values different from RIAS due to emission factor change (using 99.3)

Labelling and Promotion

Since 1978, the EnerGuide label has enabled Canadians to compare the energy consumption of an appliance with that of another. In 1995, placing an EnerGuide label on major electrical household appliances and room air conditioners became mandatory, with the introduction of the *Energy Efficiency Regulations*. Placing a label on a product before the first retail sale shows consumers how much energy a product uses, enabling them to consider the most energy-efficient purchase.

A voluntary EnerGuide rating for gas furnaces, central air conditioners and heat pumps was introduced in 1997. Since these products are typically purchased from a product brochure or catalogue, placing a label on the product would not be useful. Manufacturers are encouraged to print an EnerGuide rating in product brochures or catalogues, so consumers can compare the efficiency of the product when they are in the buying process. To date, manufacturers representing 85 percent of the products in the marketplace participate in the EnerGuide rating program and publish the ratings in their brochures.

In 2001, EnerGuide ratings for oil furnaces were introduced. In the fall of 2003, coincident with the requirement in Canada's *Energy Efficiency Regulations* to test, verify and report on fireplace efficiency, manufacturers were asked to integrate EnerGuide Fireplace Efficiency ratings in their brochures.

FIGURE 2-2

EnerGuide Label

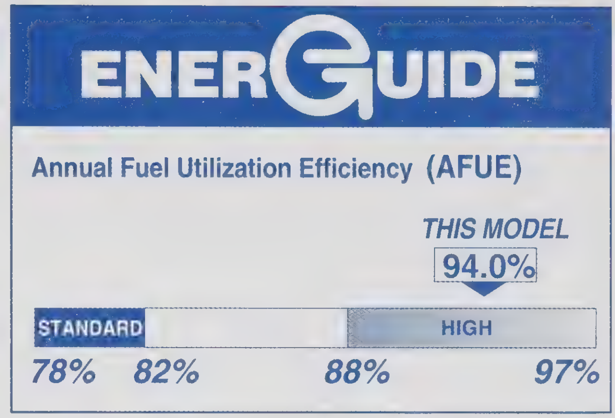
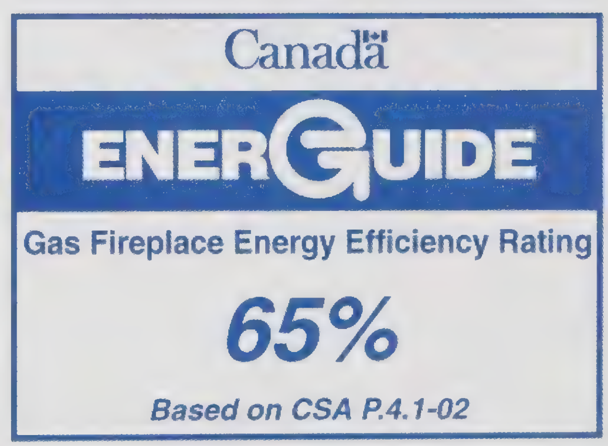


FIGURE 2-3

EnerGuide Label



EnerGuide directories with energy ratings for major appliances and room air conditioners are published each year and distributed to consumers, retailers and appliances sales people. In fulfilling requests for information, electric utilities and provincial governments also distribute the directories. On-line directories for all appliances and heating and cooling equipment are available and updated monthly.

Regularly conducted surveys indicate that over 50 percent of Canadians are aware of the EnerGuide label.

FIGURE 2-4

EnerGuide Label

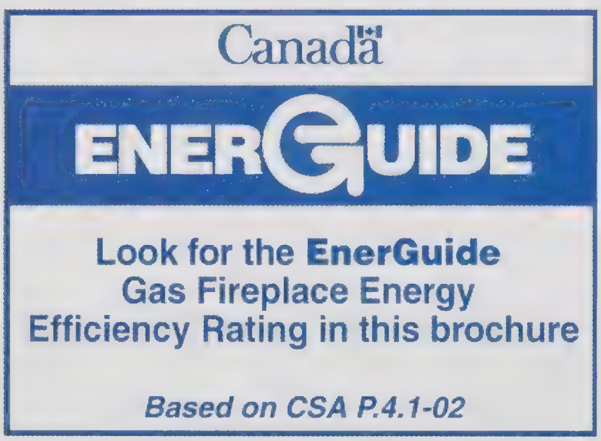


FIGURE 2-5

ENERGY STAR® Label

Responding to a desire by Canadians to have a labelling system designed to identify the best performers, Canada officially introduced, in 2001, ENERGY STAR, the international symbol for energy efficiency. An agreement was signed with the U.S. Environmental Protection Agency and the U.S. Department of Energy. The Office of Energy Efficiency is the official custodian of the program for Canada. Canada became the fifth country to join the ENERGY STAR program with Australia, New Zealand, Japan and Taiwan. The European Union has adopted ENERGY STAR for office equipment.

ENERGY STAR establishes high efficiency criteria and levels for select products for the residential and commercial sectors. Product categories are selected for the technical potential for high efficiency. This is a voluntary program. However, organizations must demonstrate that products meet the admissibility criteria and high performance levels endorsed by ENERGY STAR. For appliances and heating and cooling products, the criteria are based on the same test standards as those required under the *Energy Efficiency Regulations* and are used to qualify products for the ENERGY STAR symbol.

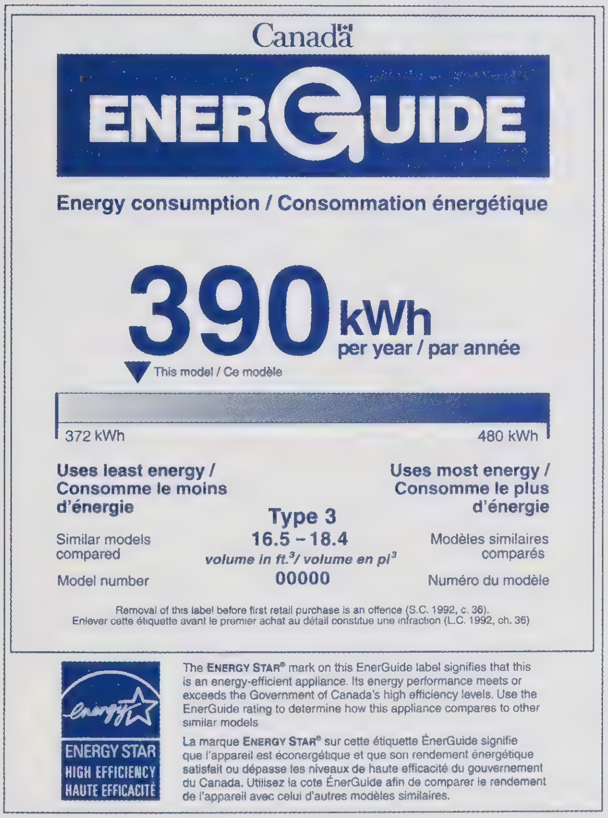
Canada promotes specific product categories where levels and criteria can be harmonized with those of the United States, including the following:

- Major appliances
- Heating, cooling and ventilation
- Consumer electronics
- Office equipment
- Windows and doors (Canadian levels)
- Some lighting (not fixtures)
- Some commercial equipment

Canada has also integrated ENERGY STAR with the EnerGuide label for major appliances and room air conditioners, to help consumers identify the best-performing products. While the EnerGuide label shows how much energy a product uses under normal conditions in one year, the ENERGY STAR symbol on the label identifies the most energy-efficient product. ENERGY STAR also combines with EnerGuide ratings for gas furnaces, central air and air-to-air heat pumps.

FIGURE 2-6

EnerGuide/ENERGY STAR Label



Having established industry-accepted norms for high efficiency, ENERGY STAR has become the criterion to meet for incentive and rebate programs.

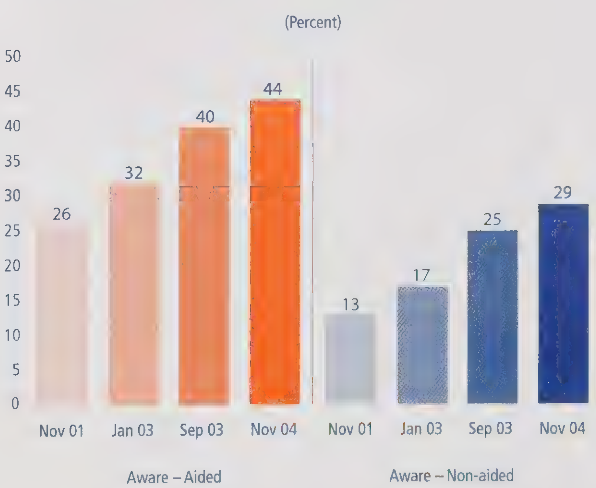
As part of the *Government of Canada Action Plan 2000 on Climate Change,* pilot projects have been implemented in partnership with seven Canadian gas utilities and a non-government organization to promote the purchase of ENERGY STAR qualified gas furnaces and boilers. From 2001 to 2005, 57 365 rebates for high-efficiency furnaces and boilers have been provided to Canadians. The partners' contribution amounted to $12 million; Canada's, $8 million. With NRCan participation, some utilities doubled the number of rebate and/or loan recipients compared to their previous programs. The participating organizations also coordinated the delivery of coupons by manufacturers, to complement the incentive. These incentives were designed to address three major barriers to higher efficiency: awareness, accessibility to high-efficiency products and acceptance.

ENERGY STAR was also used as the basis for sales tax rebates in Ontario and Saskatchewan for the purchase of qualifying appliances (refrigerators, dishwashers, clothes washers and freezers). Organizations across Canada have used ENERGY STAR as a campaign driver to promote replacement with, or purchase of, higher efficiency products.

Surveys on the awareness of ENERGY STAR have shown an increase in awareness and understanding of the symbol since 2001. Recognition of ENERGY STAR has evolved from seeing the symbol on computer equipment, to more often seeing it on major appliances.

FIGURE 2-7

Awareness Levels of ENERGY STAR in Canada



As a result of continued efforts to promote ENERGY STAR qualified appliances, industry figures show an increase in market penetration.

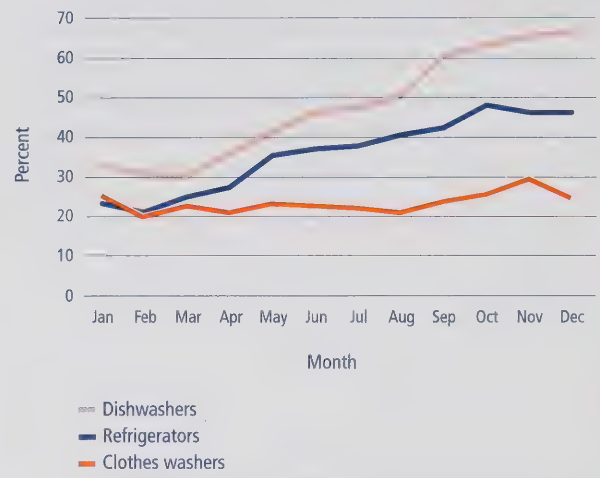
ENERGY STAR is also well known in the commercial sector, with criteria for products ranging from office equipment to traffic signals. NRCan supports demonstration projects to validate the savings and other benefits of some of these products and address barriers to their widespread acceptance. One example would be support for the installation and monitoring of LED traffic signals in Winnipeg to confirm their excellent performance in cold-weather climates.

Canada has introduced ENERGY STAR guidelines for procurement officials. It has developed an interactive cost calculator that compares energy cost savings and GHG emissions reductions associated with the purchase of ENERGY STAR qualified products. A series of workshops were launched across Canada to make governments, institutions and city officials aware of the ENERGY STAR criteria and procurement tools. ENERGY STAR will also be featured prominently in the new federal green procurement policy.

Canada continues to expand the type of products included in its ENERGY STAR agreement. As an example, Canada has recently included vending machines, commercial refrigeration, compact fluorescent lamps and commercial clothes washers in its exchange of letters with the United States government.

FIGURE 2-8

ENERGY STAR Qualified Appliances as a Percent of Total Category Sales in Canada in 2003



Chapter 3: Housing

Energy Use and Greenhouse Gas Emissions

The residential sector includes four major types of dwellings: single detached, single attached, apartments and mobile homes. Energy is used in dwellings for space heating and cooling, heating water, and operating appliances, electronic equipment and lights. This sector accounts for 17.2 percent (1458 petajoules) of secondary energy use and 15.9 percent (80 megatonnes) of greenhouse gas (GHG) emissions.

Most dwellings in Canada are single detached houses, followed by apartments, single attached dwellings and mobile homes (see Figure 3-1). Because single detached and attached houses predominate, most Natural Resources Canada (NRCan) residential building programs focus on these types of dwellings.

Space and water heating make up 81.3 percent of residential energy use, followed by the shares devoted to operating appliances, lighting and space cooling (see Figure 3-2).

Between 1990 and 2003, residential energy use increased by 13.0 percent, or 168 petajoules (from 1289 to 1458 petajoules). From 1990 to 2003, GHG emissions from the residential sector increased by 14.8 percent. GHG intensity changed little because fuel switching towards less GHG-intensive fuels offset an increase in the GHG intensity of electricity production over the period.

Four main factors tended to influence residential energy use – activity, weather, structure and energy efficiency:

- activity – the increase in the number of households and the size of dwellings (the principal measures of residential activity) increased energy use by 25.7 percent (332 petajoules).
- weather – a colder winter and a warmer summer in 2003 compared with 1990 led to an increase in space-conditioning requirements. This increased energy use by 3.3 percent (42 petajoules).
- structure – the percentage shares of energy end-uses changed over the period such that they increased energy use by 3.5 percent (45 petajoules).
- energy efficiency – improvements in energy efficiency decreased energy use by 19.4 percent (251 petajoules).

FIGURE 3-1

Canadian Households by Type of Dwelling, 2003

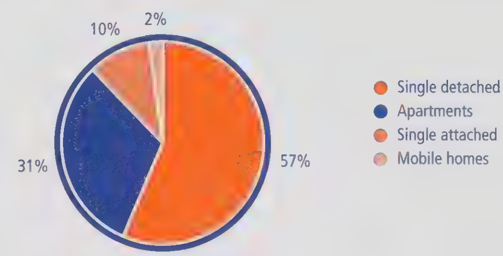
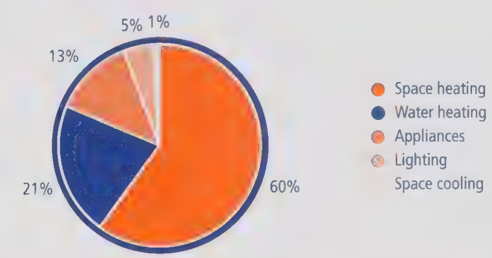


FIGURE 3-2

Residential Energy Use by Purpose, 2003



Growth in residential energy use was driven in large part by growth in activity. This increase was partially offset by significant improvements in energy efficiency. Structural changes had a minor impact on residential energy use.

The change in overall residential energy use from the years 1990 to 2003, as well as the estimated energy savings due to energy efficiency, is shown in Figure 3-3. Figures 3-4 and 3-5 show how energy consumption differs for houses built to different standards and in different periods, reflecting improvements in building construction. Figure 3-6 shows how average energy consumption of new appliances has improved by comparing 1990 and 2003 models.

NRCan delivers initiatives to increase energy efficiency in the following residential sub-sectors:

- new houses
- existing houses
- residential equipment (refer to Chapter 2)

FIGURE 3-3

Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003

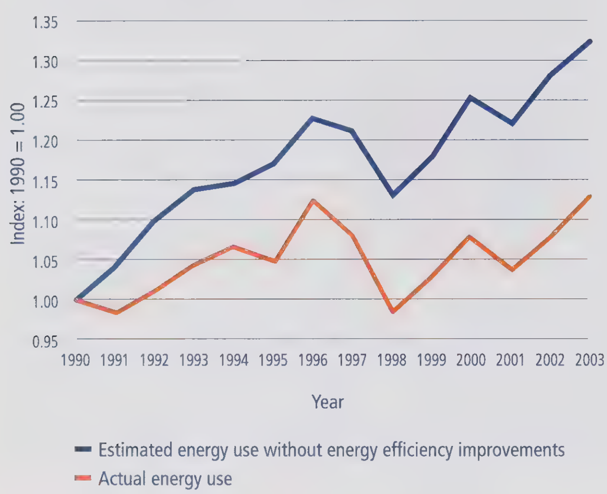
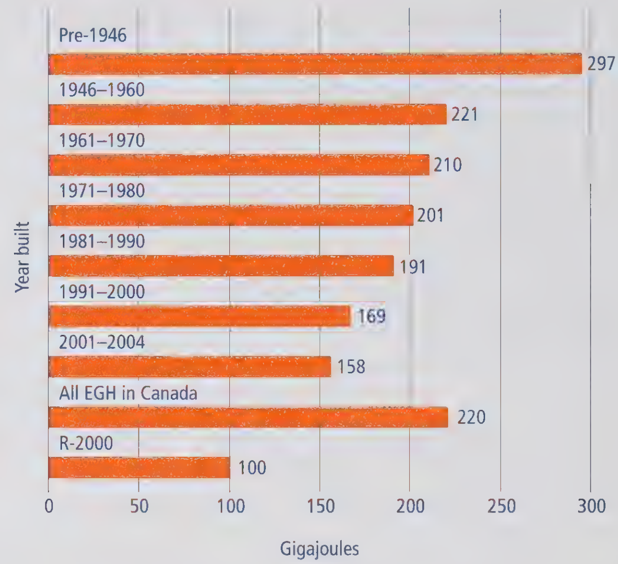


FIGURE 3-5

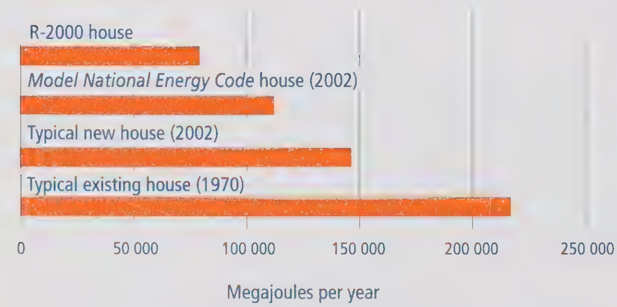
Average Energy Consumption per Household*, Pre-1946 to 2001–2004 Construction



* From R-2000 and EnerGuide for Houses programs

FIGURE 3-4

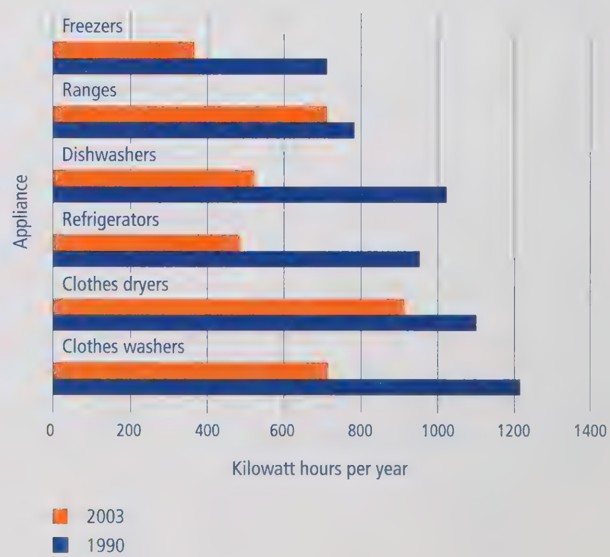
Annual Heating Consumption for Houses* Constructed to Different Standards



* 198-m² one-storey, single detached house heated with natural gas, Ottawa, Ontario

FIGURE 3-6

Average Energy Consumption of New Appliances, 1990 and 2003 Models



New Houses: R-2000 Standard and EnerGuide for (New) Houses

Objective: To increase market adoption of energy-efficient new houses by promoting changes in construction practices and by labelling houses for energy performance.

The R-2000 Standard is a voluntary technical performance standard that encourages Canadian builders to build, and Canadian consumers to purchase, houses that are more energy efficient and environmentally responsible than is required by current Canadian building codes. NRCan trains and licenses R-2000 homebuilders and other professionals in R-2000 Standard construction techniques and practices, and provides third-party quality assurance by testing and certifying R-2000 homes.

EnerGuide for (New) Houses is an energy-performance rating and labelling scheme designed to encourage the industry to build, and consumers to purchase, more energy-efficient houses. The EnerGuide for Houses (EGH) scheme is based on the R-2000 Standard and training, and it targets large-volume, mass-market builders.

Key 2004–2005 Achievements

- Over 2200 industry professionals received training in energy-efficient construction techniques and the sizing and installation of high-efficiency heating and ventilation systems.
- EnerGuide for New Houses rating scheme was launched; over 40 of Canada's largest tract builders are participating.
- Building Canada teams from western, central and eastern Canada are now involved in recruiting and training key, very large-volume builders to construct and EGH-label energy-efficient houses.

For more information:
oee.nrcan.gc.ca/r-2000/english

R-2000 is an official mark of Natural Resources Canada.

FIGURE 3-7

Number of Eligible R-2000 Housing Starts, 1990 to 2004

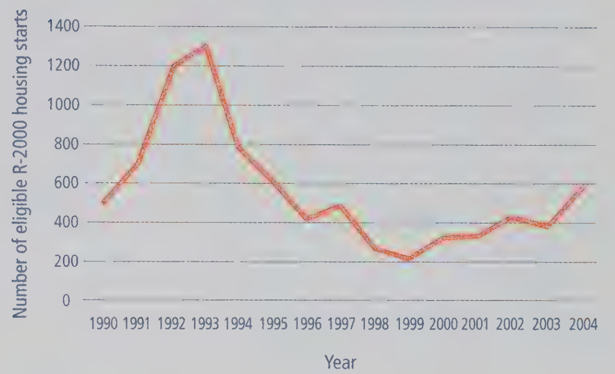
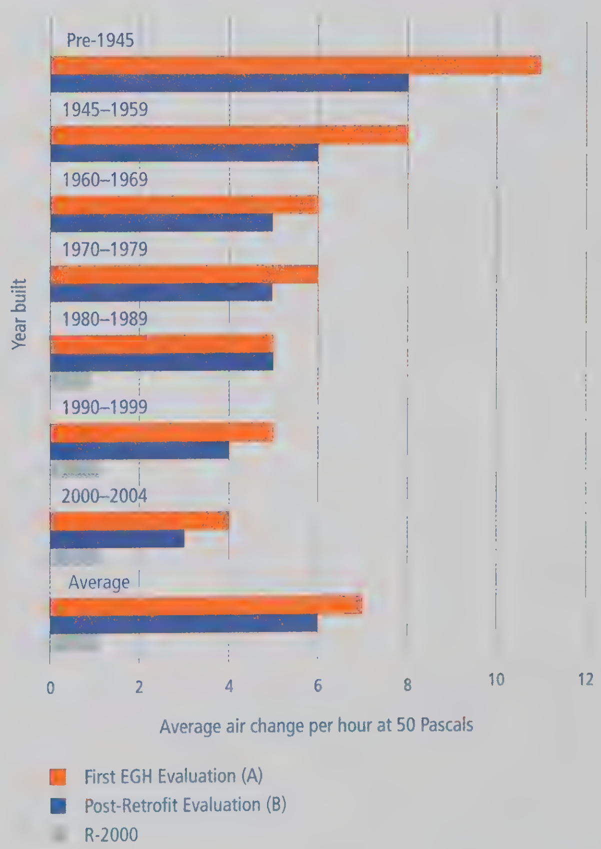


FIGURE 3-8

National Trends in Air Leakage, Pre-1945 to 2000–2004 Construction



New Houses: Housing Energy Technology Program

Objective: To accelerate the development and market adoption of energy-efficient housing technologies.

Working in partnership with associations, government and industry, the CANMET Energy Technology Centre (CETC) manages this program to develop and deploy highly specialized solutions that help reduce, in a cost-effective manner, the energy consumption and GHG emissions of Canadian houses. Progress to date includes the identification, accelerated development and broader deployment of a number of promising technologies, such as advanced integrated mechanical systems (now trademarked ēKOCOMFORT™) and electronically commutated motors.

In whole house design, the development and technical support of the R-2000 Standard has led to extensive technology development and deployment throughout the housing sector. Through its associated Building Energy Simulation Program, CETC's software tools are widely used to assess the energy use in a home. CETC also develops more energy-efficient frames for windows and is a lead managing agency for the Canadian Centre for Housing Technology (CCHT), an advanced testing facility for assessing whole-house impacts of emerging technologies.

Key 2004–2005 Achievements

- Field trials with five manufacturing groups of the ēKOCOMFORT system were completed. These involved oil and gas installations in new and retrofit units in southern Ontario and Nova Scotia. First generation products proved to be robust and carry out expected functions in the field. The results also indicated significant electrical savings. These results are now being used by manufacturers that are developing second generation products.
- Three residential Combined Heat and Power (CHP) technologies have been installed at the CCHT in the last year. These include the first Canadian installation of a residential fuel cell; the installation of three residential-scale solar photovoltaic systems; and both the installation and testing of a Stirling Engine.
- Completed an assessment of energy-efficient ventilation strategies that improve indoor air quality. Results showed that running your furnace fan at frequent and regular intervals does improve the indoor air quality of a home by ensuring sufficient fresh air in all spaces throughout the house at appropriate times. This was shown to be a less costly alternative to running the fan continuously.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

ēKOCOMFORT is a Trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

New Houses: Super E™ House Program

Objective: To build capacity for exporting energy-efficient, durable and environmentally friendly Canadian housing technology to foreign markets.

The Super E™ House Program is a strategic housing export initiative delivered by NRCan as part of the Team Canada export strategy. The program adapts internationally leading Canadian energy efficiency standards to foreign markets and identifies appropriate technologies for them to create unique market opportunities for Canadian housing technology companies. Launched in 1998, the Super E House Program has facilitated partnerships between Canadian builders and their foreign counterparts to increase market penetration of Canadian energy-efficient technologies internationally.

The Canada Mortgage and Housing Corporation (CMHC), the Canadian Forest Service (CFS) and CETC financially support the Super E U.K. program. The Super E Japanese program is financially supported by CETC with in-kind support from CMHC. In both cases, there is strong support from the Department of Foreign Affairs and International Trade (now divided into Foreign Affairs Canada and International Trade Canada). Industry members also contribute to the success of the program through in-kind and financial contributions (member fees).

The Super E House Program is attracting demand and generating real economic benefits back to Canada in the form of at least $30 million for Canada to date. There are 65 Canadian and international companies involved in the program and over 550 houses have been built or contracted in Japan and the U.K.

Key 2004–2005 Achievements

- Launched a new partnership with CMHC to incorporate seniors and flex housing elements into the Super E program in Japan. There is a documented demand for energy-efficient, healthy and comfortable facilities for the growing population of seniors in Japan.
- A five-year contract was signed under the Super E program in the U.K. for 1400 Super E units commencing in January 2005. This represents $100 million in value.
- Official opening of a Super E demonstration house in Beijing, China, was held in March 2005, one of two projects currently active in China. The project was built in partnership with the Council of Forest Industries and the Chinese Academy of Forests. The home will be monitored for energy performance and wood moisture content, and the results will help guide future energy and building code regulatory policy in China for low-rise wood-frame housing.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

Super E is an official mark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

Existing Houses: EnerGuide for Houses and Retrofit Incentives

Objective: To encourage Canadians to improve the energy efficiency of their homes.

EnerGuide for Houses (EGH) provides Canadian homeowners with personalized expert advice on how to best improve the energy performance of their houses, especially when undertaking renovation and maintenance projects. Under EGH, a retrofit incentive was officially launched in October 2003. Homeowners can now qualify for a non-taxable grant, which represents about 10 to 20 percent of their expenditures, when they retrofit their homes. The grant is based on the differential improvement in the house's energy rating, as measured by a pre- and post-renovation EGH energy evaluation.

Key 2004–2005 Achievements

- Over 77 000 houses evaluated and labelled.
- Issued over 17 000 grants, totalling over $10 million.
- Reduced energy consumption by an average 27 percent in post-retrofit homes; grant recipients reduced carbon dioxide by an average of 4 tonnes per year, per house.

FIGURE 3-9

Evaluations Under EnerGuide for Houses, 1998–1999 to 2004–2005

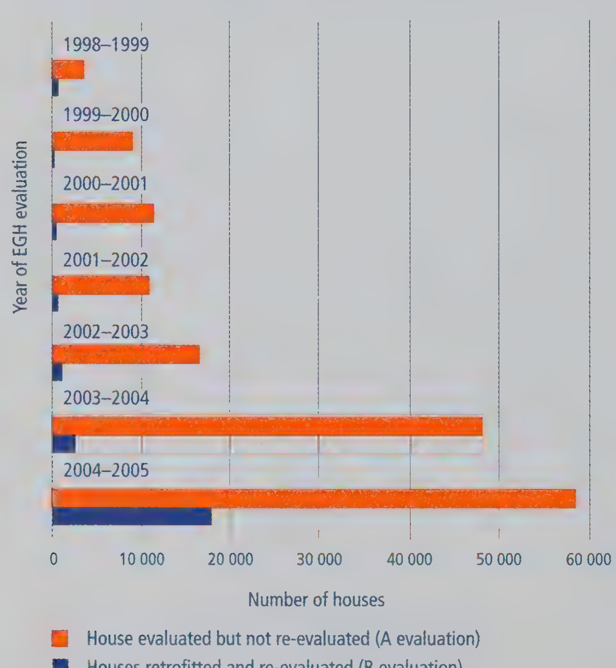
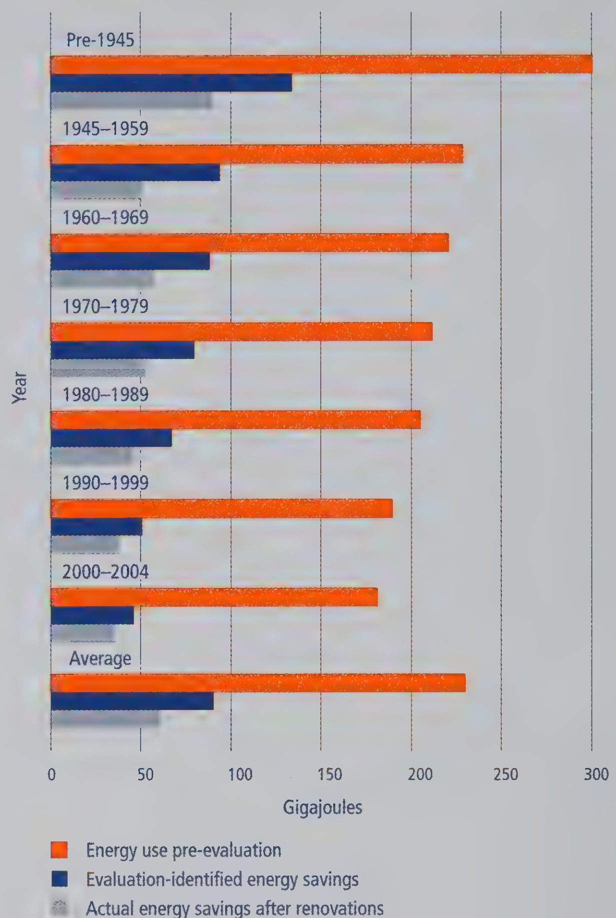


FIGURE 3-10

Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2004



For more information:
energuideforhouses.gc.ca

Chapter 4: Buildings

Energy Use and Greenhouse Gas Emissions

The commercial/institutional sector includes activity related to trade, finance, real estate, public administration, education and commercial services, including tourism. This sector uses energy mainly for space and water heating, space cooling, lighting, motive power for services such as pumping and ventilation in buildings, and street lighting.

In 2003, the total commercial/institutional sector accounted for 14.0 percent (1181 petajoules) of secondary energy use and 13.8 percent (69.3 megatonnes) of greenhouse gas (GHG) emissions.

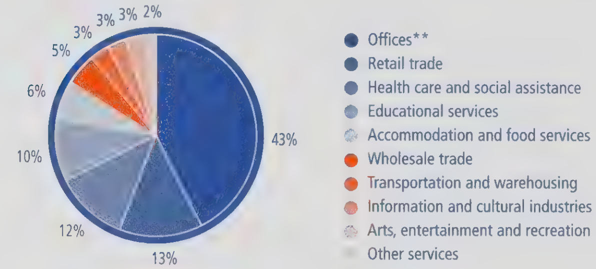
To highlight energy use in commercial/institutional activities, the following analysis excludes energy use for street lighting. The commercial/institutional sector comprises many activity types (see Figure 4-1). Retail trade and offices account for more than half of commercial/institutional sector energy demand. Health care and social assistance, accommodation and food services, and educational services account for another 28 percent of that demand. Natural Resources Canada's (NRCan's) initiatives address all of these major energy-using activity types.

Energy is used for six purposes in commercial/institutional activities. The largest of these is space heating, which accounts for more than half of energy use in this sector (see Figure 4-2). Each of the remaining five uses of energy accounts for between 6 and 13 percent of energy demand in this sector.

Between 1990 and 2003, commercial/institutional energy use, excluding street lighting, increased by 36.6 percent, or 314 petajoules (from 858 to 1172 petajoules). However, GHG emissions from the sector rose by 45.2 percent in the same period. Emissions increased more quickly than energy use due to the increased use of energy sources with a higher GHG content.

FIGURE 4-1

Commercial/Institutional Energy Use by Activity Type*, 2003

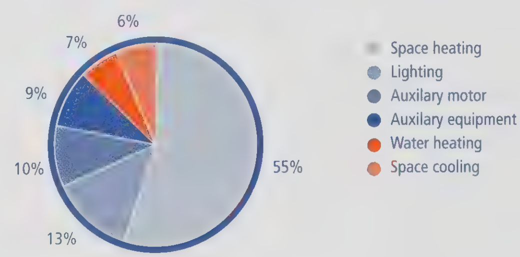


* Excludes street lighting

** "Offices" includes activities related to finance and insurance; real estate and rental and leasing; professional, scientific and technical services; and public administration.

FIGURE 4-2

Commercial/Institutional Energy Use by Purpose*, 2003



* Excludes street lighting

During 1990–2003, a steady increase in activity largely contributed to increased energy use. To a lesser degree, the service level for auxiliary equipment, structure (the mix of building types) and weather also each played a role. However, energy efficiency slowed this rate of increase. Specifically, the energy use changes attributed to each of these factors are

- activity – a 25 percent increase in floor space resulted in a 223-petajoule increase in energy use
- weather – fluctuations in weather resulted in a 3.4 percent increase in energy use (29 petajoules)
- structure – a shift in activity resulted in a 0.1 percent increase in energy use (1 petajoule)
- service level – a higher service level for end-users resulted in an 8.3 percent increase in energy use (71 petajoules)
- energy efficiency – a 1.1 percent improvement in energy efficiency resulted in a decrease of 10 petajoules

Without improvements in energy efficiency, increases attributable to activity, weather, structure and service level would have led to an increase in commercial/institutional energy use of 37.7 percent (323 petajoules). However, as a result of a 1.1 percent improvement in energy efficiency, actual energy use increased by 36.6 percent. This change in energy use during 1990–2003, as well as the estimated energy savings due to energy efficiency, is shown in Figure 4-3. Figure 4-4 shows how energy use in commercial buildings compares to certain standards.

NRCan delivers initiatives to increase energy efficiency in the following sub-sectors of the commercial/institutional sector:

- new buildings
- existing buildings
- equipment (refer also to Chapter 2)
- community energy systems

FIGURE 4-3

Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003

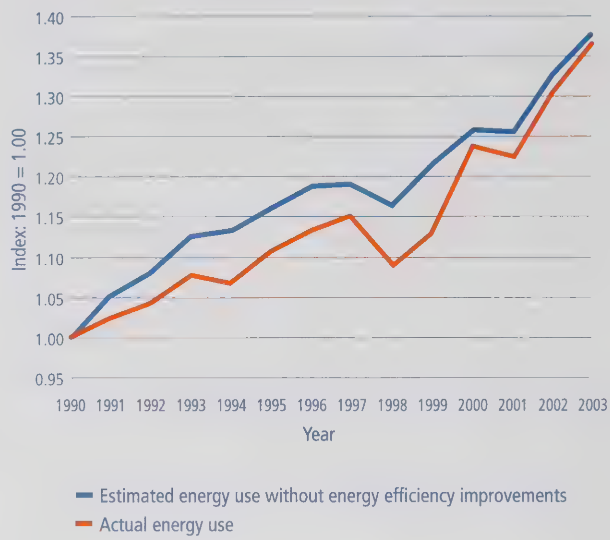
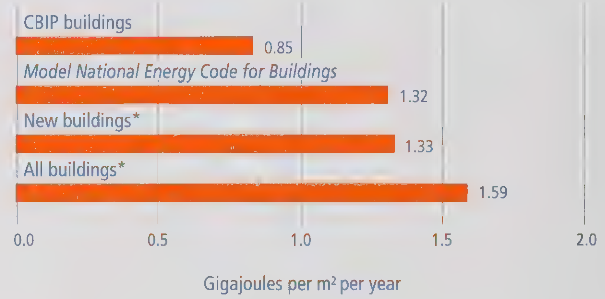


FIGURE 4-4

Energy Use in Commercial Buildings



* Source: Commercial and Institutional Building Energy Use Survey (CIBEUS), 2000. Estimates relate only to the surveyed area of populations over 175 000, and in Atlantic Canada to populations over 50 000.

New Buildings: Commercial Building Incentive Program

Objective: To improve the energy efficiency of new commercial, institutional and multi-unit residential buildings.

The Commercial Building Incentive Program (CBIP) provides financial incentives to builders and developers who incorporate energy-efficient features into the design and construction of new commercial, institutional and multi-unit residential buildings. To qualify for the incentive, buildings must be at least 25 percent more energy efficient than similar buildings constructed to the *Model National Energy Code for Buildings* (MNECB). However, results indicate that CBIP buildings are on average 35 percent better than similar buildings constructed to the MNECB. The program is delivered by the Government of Canada and co-marketed by a number of provincial/territorial utilities, provincial/territorial energy efficiency and climate change agencies, and building professional organizations.

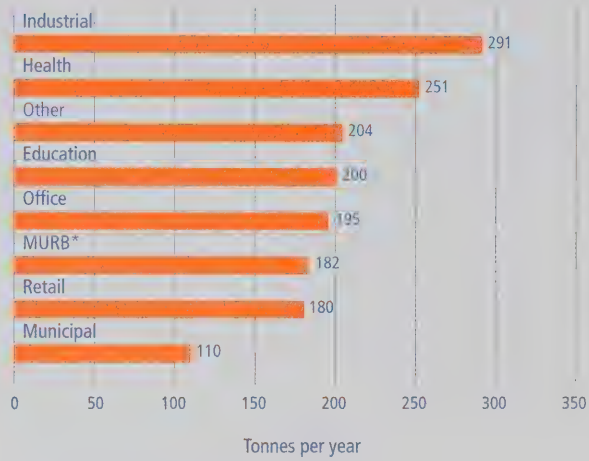
Key 2004–2005 Achievements

- Incentives given to 165 projects during 2004–2005, representing 32 percent of the 519 projects incented since the launch of the program in 1998.
- Through its partnership with the Canada Green Building Council (CaGBC), the CBIP criteria of 25 percent better than the MNECB was adopted as a prerequisite for the LEED (Leadership in Energy and Environmental Design) Green Building Rating System.
- The Retail Food sector, which accounts for about 30 percent of new construction activity in Canada, became fully engaged in the program, with 42 newly constructed supermarkets achieving the CBIP criteria in 2004–2005.

For more information:
oee.nrcan.gc.ca/newbuildings

FIGURE 4-5

Estimated Average GHG Reductions by Type of Institution Under CBIP, 2004



*Multi-unit residential building

New Buildings: Industrial Building Incentive Program

Objective: To improve the energy efficiency of new industrial buildings.

The Industrial Building Incentive Program (IBIP), a demonstration program, extends the precepts of CBIP to the industrial sector. IBIP offers an incentive to companies building new energy-efficient industrial facilities to offset additional design costs inherent in the initial attempts at energy-efficient designs and building/process integration. The design is assessed against a reference generated from the MNECB.

Key 2004–2005 Achievements

- Five contribution agreements were signed, bringing the number of projects supported since the launch of the program in 2002 to 20.
- Three case studies were prepared.
- The *IBIP Technical Guide* was updated.

For more information:
oee.nrcan.gc.ca/newbuildings

New Buildings: Green Buildings Program

Objective: To reduce energy use, resource consumption and emissions from commercial buildings through design, construction and retrofitting while increasing cost-effectiveness.

The program plays a significant role in establishing goals for energy efficiency and sustainability in commercial buildings through a variety of key activities. Through CETC's C-2000 Program for Advanced Commercial Buildings – which was a small demonstration program for high-performance buildings – CETC worked with industry to demonstrate buildings that reduce energy consumption by 50 percent and water consumption by 40 percent. The program continues to provide the necessary tools, guidelines and techniques through its integrated design process (IDP) for industry and associations to use to produce optimized, energy-efficient green buildings and green building programs.

The program also provides ongoing support to NRCan programs such as CBIP by developing guidelines, providing technical support and developing downloadable simulation software tools that perform accurate building analysis, assist in design and measure compliance with these incentive programs.

NRCan launched the Green Building Challenge (GBC) in 1996 (now managed by a third party) and established Sustainable Building conferences to showcase the results and best practices of the competing energy-efficient buildings. GBC brings together more than 20 countries focused on the development and testing of an internationally accepted system for assessing the environmental performance of buildings. The NRCan-developed electronic GBTool™ is used in the assessments.

Key 2004–2005 Achievements

- Recently, the new $7.5-million, 50 000-square-foot Canadian headquarters for Smith Carter Architects and Engineers Incorporated officially opened in Winnipeg, having been designed with assistance from CETC's C-2000 experts. It is being hailed as the most energy-efficient, environmentally friendly office in Manitoba and one of the greenest in Canada.

- CETC supported the development of LEED Canada – an industry-driven assessment system for green buildings – by helping with the development of criteria for its rating system and participating in the committee that helped form CaGBC, the organization responsible for LEED Canada.
- CETC assisted in development of the new version of its GBTool™, which was used by international teams to assess submissions for the 2005 World Sustainable Building Conference held in Tokyo in September 2005.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

GBTool is a Trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

Existing Buildings: Energy Innovators Initiative

Objective: To encourage commercial businesses and public institutions to become more energy efficient and reduce their GHG emissions that contribute to climate change.

The Energy Innovators Initiative (EII) helps commercial organizations and public institutions explore energy efficiency options and strategies, offering them access to tools and financial assistance to help reduce energy costs and improve competitiveness. Members join the EII by sending a letter to the Minister of Natural Resources from senior management stating their commitment to energy efficiency. Currently, over 2000 commercial, institutional and multi-unit residential organizations across Canada are Energy Innovators.

After joining the EII, members can apply for Energy Retrofit Assistance (ERA) funding for retrofit planning activities and retrofit implementation projects in existing commercial/institutional buildings.

Key 2004–2005 Achievements

- EII program membership surpassed 2000 Canadian organizations.
- Twenty-one formal partnerships were established through contribution agreements with member-based associations.
- Since 1998, approved energy retrofit projects have involved over 4800 member buildings.

TABLE 4-1

Energy Innovators Initiative – Incentive Projects, 1998 to 2005 (Millions of dollars)

Federal incentive	52.3
Client investment	888.1
Annual energy cost savings	122.8

For more information:
oee.nrcan.gc.ca/eii

Equipment: Refrigeration Action Program for Buildings

Objective: To support the development and the adoption of innovative refrigeration technologies that reduce energy consumption, synthetic refrigerant use and GHG emissions in commercial and institutional buildings.

The Refrigeration Action Program for Buildings (RAPB) was launched in 2003 under the *Climate Change Plan for Canada* and focuses on the deployment of innovative refrigeration technologies integrated with a building's heating, ventilating and air-conditioning (HVAC) systems, in order to drastically reduce refrigerant losses, allow the recovery and upgrade of the heat rejected by the refrigeration system, and adapt the system's operation to the Canadian climate. To meet its objective, the RAPB performs capacity building, demonstration, information and training activities in partnership with key stakeholders, for Canadian supermarkets, ice rinks and curling rinks. The RAPB also undertakes research and development activities on refrigeration technological solutions.

Key 2004–2005 Achievements

- Launched and are successfully operating a demonstration project of innovative integrated HVAC and refrigeration technologies at the Loblaws Inc. supermarket in Repentigny, Quebec. CETC–Varennes provided technical support for the design and installation phases of the project and carries out performance analysis of the system implemented.
- Commenced three demonstration projects of an innovative integrated HVAC and refrigeration system for ice rinks, manufactured by the Canadian company CIMCO Refrigeration (a Division of Toromont Industries Ltd). The projects are in Fort Saskatchewan, Alberta; Pilot Mound, Manitoba; and La Pêche, Quebec. CETC–Varennes will provide technical support and carry out performance analysis of the implemented systems.
- As part of the deployment program, training sessions and workshops have been launched across Canada to create awareness of and build capacity on innovative refrigeration technologies and practices.

For more information:
cetc-varennes.nrcan.gc.ca/en/ref.html

Equipment: Buildings Program – Intelligent Buildings

Objective: To develop and promote the adoption of intelligent building technologies and innovative building operation practices that reduce energy consumption and GHG emissions.

The program focuses on intelligent building technologies and practices, such as re-commissioning, that reduce a building's energy consumption while ensuring the occupants' comfort and preserving indoor air quality. To meet its objectives, the program develops, demonstrates and deploys, in partnership with key stakeholders, intelligent buildings technologies in Canadian commercial/institutional buildings.

Key 2004–2005 Achievements

- Organized, at CETC–Varennes, RECOM 2004 – a workshop to increase awareness about the impacts of the optimization of building operation. The workshop attracted more than 50 people from the public, private and academic sectors.
- Signed a Memorandum of Understanding between CETC–Varennes and Public Works and Government Services Canada for optimizing the operation of eight federal buildings across Canada using the software tool DABO, the Diagnostic Agent for Building Operators, developed by CETC–Varennes.

For more information:
cetc-varennes.nrcan.gc.ca/en/b_b/bi_ib.html

Equipment: Building Energy Simulation Program

Objective: To contribute to the improvement of design, performance, cost-effectiveness, integration and deployment of energy-efficient building technologies and techniques, through simulation modelling and applications-driven implementation tools for the market.

Through this program, the Simulation Team develops, distributes and supports building simulation software for the Canadian housing and building industry. These software tools are used by architects and engineers to optimize the energy performance of individual technologies and whole building designs, as well as to demonstrate compliance with such programs as the R-2000 Standard, EnerGuide for Houses and (New) Houses, CBIP, the *Model National Energy Code for Buildings* and the *Model National Energy Code for Houses*. The team is involved in all aspects of the software development process, from design and programming to distribution, maintenance, and user training and support.

The Simulation Team developed the next generation residential energy analysis software, HOT3000™, a more advanced version of HOT2000™, with a more comprehensive and expandable simulation engine (based on the ESP-r program). HOT3000 is capable of expanding to meet the complexities of the energy-saving technologies and strategies entering the market and emerging in industry research and development. The ESP-r program was created by the University of Strathclyde in Scotland and modified by CETC to meet Canadian simulation needs. The University of Strathclyde remains a collaborator on several simulation software development projects.

Key 2004–2005 Achievements

- Developed H_2 Cogen, a software program to help analyse the feasibility of wind-generated hydrogen-based building cogeneration systems. This system is based on the idea that excess electricity generated by a wind farm is converted into hydrogen at the building site, stored and then converted back to electricity when the building needs cannot be met directly by the wind farm.
- Continued to take a leading role in developing and validating methods for modelling cogeneration systems, by chairing a research annex for the International Energy Agency. This work included the development of a Stirling Engine model within a whole-building simulation program as well as an advanced version of a solid-oxide fuel cell model. These are important advancements in the analysis and study of distributed generation systems for buildings. Further validations of these new models will continue into the next year.
- Using CETC software, 200 000 houses and over 500 commercial buildings have been simulated for improved energy efficiency to date. Since the announcement of the EnerGuide for Houses retrofit incentive, on average, CETC software is being used 275 times per day.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_bg_e.html

HOT2000 is an official mark of Natural Resources Canada.

HOT3000 is a Trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

Community Energy Systems: Community Energy Systems Program

Objective: To increase the sustainability of Canadian communities by addressing their energy needs.

This program works in partnership with Canadian communities and businesses to address energy needs through a holistic approach to energy efficiency, renewable energy and community energy planning. NRCan has supported many district energy projects (some of which are based on renewable energy such as using waste energy from the local power plants) in Ontario, Prince Edward Island, Northwest Territories, Nunavut and Yukon. NRCan continues to help communities to develop Sustainable Community Energy Plans, using tools that are designed to reduce energy demand, emphasize conservation and promote reliance on local renewable energy sources.

Key 2004–2005 Achievements

- Continued the community energy training program and held workshops in New Brunswick, Nova Scotia and Prince Edward Island.
- Provides the planning methodology which enables municipalities to develop a long-term growth strategy while minimizing energy consumption and maximizing renewable energy. This is now being used by municipalities across the country.
- Completed the laboratory testing of a jet ejector to provide cooling using microturbine exhaust. Experiments with super-charging of microturbines has resulted in increased electrical output.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_ces_e.html

Chapter 5: Industry

Energy Use and Greenhouse Gas Emissions

The industrial sector includes all manufacturing industries, all mining activities, forestry and construction; however, it excludes electricity generation. This sector uses energy in industrial processes as a source of motive power to produce heat or to generate steam. Overall, industrial energy demand accounts for 38.4 percent (3246 petajoules) of secondary energy use and 33.7 percent (169 megatonnes) of greenhouse gas (GHG) emissions (including electricity-related emissions).

Within the industrial sector, energy is consumed primarily in pulp and paper, mining, petroleum refining, and smelting and refining industries. Pulp and paper alone accounted for about 26.2 percent of total industrial energy demand in 2003 (see Figure 5-1).

In most industries, energy purchases account for only a small proportion of total expenditures. However, for some relatively energy-intensive industries – cement, chemicals, and pulp and paper – this share is higher than 13 percent (see Figure 5-2). For cement, in particular, the share is as high as 38 percent.

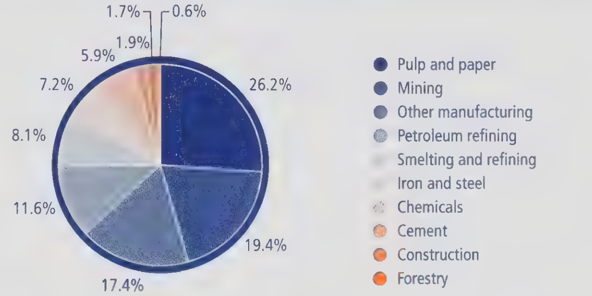
Actual industrial energy use increased by 19.4 percent (528 petajoules) between 1990 and 2003. This increase was driven by a 44.5 percent increase in industrial activity, measured as a combination of physical units of production, gross output and gross domestic product (GDP). However, some of this increase in energy use that would have resulted from the increase in activity was offset by improvements in energy efficiency and structural change – the shift to less energy-intensive industries (such as electrical and electronics).

Three main factors influenced energy use:

- activity – increases in physical units of production, gross output and GDP contributed to a 44.5 percent increase in industrial activity resulting in a 1210-petajoule increase in energy use.
- structure – the change in the mix of activity toward less energy-intensive industries resulted in a 338-petajoule decrease in energy use.
- energy efficiency – due to a 12.6 percent improvement in energy efficiency, the industrial sector avoided 344 petajoules of energy use between 1990 and 2003.

FIGURE 5-1

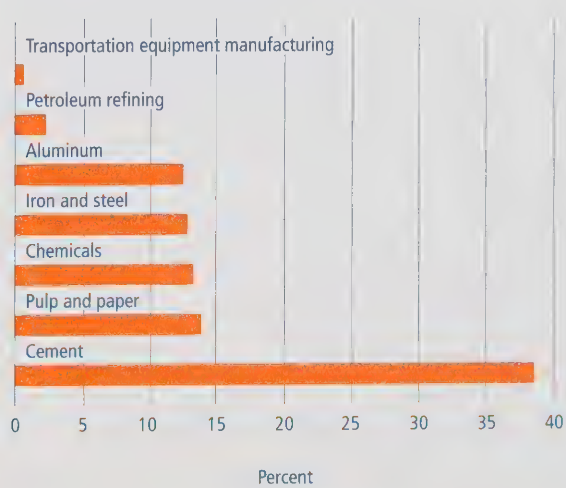
Industrial Energy Use by Sub-Sector*, 2003



* Note: The above sub-sectors reflect the current definitions in the *Quarterly Report on Energy Supply-Demand in Canada*. "Other manufacturing" comprises more than 20 manufacturing industries.

FIGURE 5-2

Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2003



The change in energy use between 1990 and 2003 and the estimated energy savings due to energy efficiency are shown in Figure 5-3.

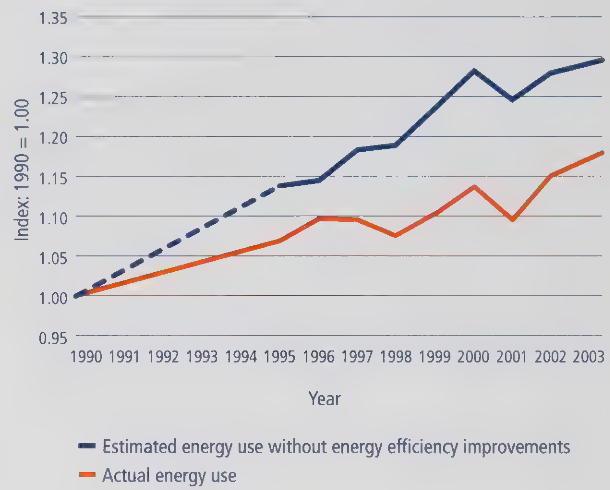
Between 1990 and 2003, industrial GHG emissions including electricity-related emissions increased by 19.2 percent. Excluding electricity-related emissions, industrial GHG emissions increased by 10.6 percent over the same period. Most of this increase in direct GHGs occurred in the upstream mining industry, since the mining (excluding upstream), manufacturing and construction industries realized a 4.4 percent decrease in GHG emissions.

Natural Resources Canada (NRCan) delivers initiatives to increase energy efficiency in the following components of the industrial sector:

- industrial processes and technologies
- equipment (refer to Chapter 2)
- buildings (refer to Chapter 4)

FIGURE 5-3

Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003



Industrial Processes and Technologies: Industrial Energy Efficiency

(Canadian Industry Program for Energy Conservation [CIPEC] and Industrial Energy Innovators [IEI])

Objective: To help Canadian industry use energy efficiency investments to improve competitiveness and to contribute to Canada's climate change goals.

CIPEC is a unique industry-government partnership committed to promoting and encouraging energy efficiency improvements and reductions in GHG emissions through voluntary action across Canada's industrial sectors. CIPEC comprises 26 sector task forces that involve 48 trade associations.

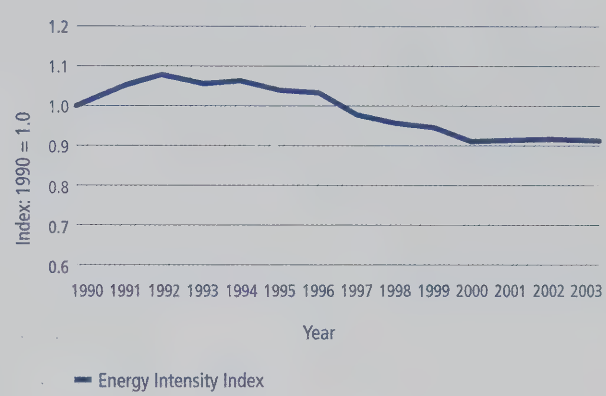
CIPEC, a sector-level program, and IEI, a company-level program, both address barriers to planning, implementing, tracking and reporting energy efficiency projects in industry. Key elements include the establishment and tracking of energy efficiency improvement targets and plans, and the development of products and services that overcome barriers to continued energy efficiency improvements. NRCan provides support via employee awareness kits and events, best-practices guides, technical and planning information, energy audits of varying sophistication, benchmarking and workshops on energy management. Information on industrial cogeneration and on determining the technical eligibilty of energy efficiency projects for the Class 43.1 Accelerated Capital Cost Allowance tax write-off is also available.

CIPEC targets all of industry, including mining, manufacturing and construction as well as upstream oil and gas and electricity generation. In 2003, CIPEC industries contributed $288.6 billion ($97 GDP) to the Canadian economy. This represents 28 percent of Canada's total GDP ($288,618 / $1,015,974). Of this amount, about 83 percent came from the Manufacturing, Mining and Construction components of CIPEC, and 17 percent came from CIPEC Energy Producers.

Between 1990 and 2003, CIPEC industries improved their energy intensity by 8.7 percent. Had energy intensity remained constant and not declined by 0.7 percent per year, GHG emissions would have been 27.8 megatonnes higher.

FIGURE 5-4

CIPEC Energy Intensity Index, 1990 to 2003



The Manufacturing, Mining and Construction components of CIPEC improved their energy intensity by an average of 1.8 percent per year, or 21.4 percent, since 1990. Although CIPEC Energy Producers' energy intensity has increased by 13.4 percent since 1990, their energy intensity has decreased by 1.4 percent since 2001.

CIPEC Industries avoided approximately $3.4 billion in energy costs in 2003, owing to effective energy management.

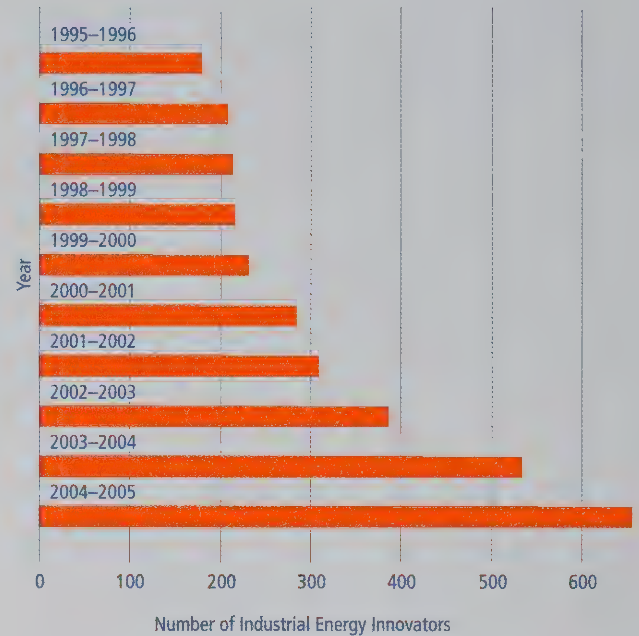
Key 2004–2005 Achievements

- Recruited 124 new Industrial Energy Innovators (see Figure 5-5).
- Initiated 137 Industrial Energy Audits.
- Had 1000 industrial participants in Dollars to $ense workshops, almost double the participation in 2003–2004.

For more information:
oee.nrcan.gc.ca/cipec/ieep

FIGURE 5-5

Industrial Energy Innovators, 1995–1996 to 2004–2005



Industrial Processes and Technologies: Cleaner Fossil Fuel Power Generation

Objective: To design, develop and deploy technologies for power generation from fossil fuels with increased efficiency and reduction and ultimately elimination of emissions of acid rain precursors, GHGs, particulates and identified priority substances – mercury, trace elements and organic compounds.

Research focuses on improving performance and reducing emissions for existing fossil fuel power plants and on developing new advanced cycles for conversion of fossil fuels to electricity with complete or near complete capture and elimination of carbon dioxide (CO_2) and other emissions. Additional research undertaken includes issues associated with the transport and storage of CO_2.

Key 2004–2005 Achievements

- Developed Canadian technology roadmaps that identify technologies that will be needed for the clean and efficient use of coal with CO_2 capture and storage. Published *CO_2 Capture and Storage Roadmap* and *Canadian Clean Coal Technology Roadmap.*
- Commissioned a new pressurized gasifier research pilot plant as part of an advanced clean coal research program. The unit, the only one of its type in North America, will act as an economical test bed for Canadian utilities interested in advanced technology development, hydrogen production and CO_2 capture. Gasification provides high electricity generation efficiency; allows CO_2 capture at low cost and low energy penalty; permits economical, highly efficient removal of sulphur oxide, nitrogen oxide and mercury; and will provide energy security through clean use of Canada's indigenous coal reserves.
- Successfully demonstrated a new measurement and characterization methodology for $PM_{2.5}$ fine particulate matter emissions. Application of Canada-wide standards to large industrial sources in 2010 will require reliable measurement methods. Developed a novel source dilution sampling and fine particulate matter (PM) measurement system for fossil fuel combustion units to provide ambient-compatible data on $PM_{2.5}$ emissions as defined by the Canadian and U.S. Ambient Air Standards. The research team received a Departmental Merit Award for this work.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_act_e.html

Industrial Processes and Technologies: Processing and Environmental Catalysis Program

Objective: To solve industrial process problems and undertake research in areas with high potential for significant environmental and economic benefits.

The program's facilities, including semi-pilot-scale plants, are used for process testing and the evaluation of novel concepts in chemical and energy conversion, including hydrogen production from hydrocarbon and renewable sources. Clients include oil and gas companies, petrochemical companies, engine manufacturers, waste oil recyclers and renderers, and specialty ceramic manufacturers.

Key 2004–2005 Achievements

- Developed technology for the production of low-sulphur, high-cetane blending stock from waste restaurant grease and vegetable oils. A royalty-bearing licence agreement for Cetaner technology was signed with North Texas BioEnergy Ltd.
- Developed a catalytic process for producing ethanol from acetic acid. Catalyst testing was done for Woodland Chemicals, a technology development company that has proprietary technology for producing fuel ethanol from biomass residues.
- Developed a direct carbon fuel cell to convert carbon-rich solids to electricity. A 10-watt unit was designed, and a cold flow model was built and tested. A collaborative research agreement is being negotiated with a fuel cell manufacturer in order to facilitate the fuel cell's development.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_pec_e.html

Industrial Processes and Technologies: Industrial System Optimization Program

Objective: To support the development and adoption of innovative energy-efficient design practices in Canadian industry to improve its energy efficiency and productivity, while decreasing GHG emissions and other environmental impacts.

The program focuses on plant-wide industrial process analysis techniques, such as Process Integration (PI) and advanced process control systems, to identify and correct inefficiencies in plant operation and design taking into account energy, economy and environmental aspects. It seeks to meet its objective by performing leveraged research and development through national and international collaboration. Furthermore, the program disseminates technical information that will encourage the adoption of these practices in targeted energy-intensive sectors of Canadian industry including pulp and paper, oil upgrading and refining, petrochemicals, steel, chemicals, food and drink, and solid wood.

Key 2004–2005 Achievements

- Conducted a successful program to demonstrate the benefits of PI for medium-sized processes in small- and medium-sized enterprises: four plant-wide energy analyses completed in the food and drink and textile industries. Together, these studies allowed the participating companies to identify cost-effective energy- and water-savings projects that can lead to savings of $3 million per year, with an average pay back period of less than two years and CO_2 emission reductions of 14 000 tonnes per year (energy efficiency improvements of 20 to 35 percent).
- Completed an opportunity analysis and technology assessment of sludge upgrading systems for energy production as a viable alternative to land filling in the Canadian pulp and paper mills. The work was coordinated by an advisory committee formed by specialists from major pulp and paper companies, research centres and federal departments. This technological-economic assessment will help industry select the most cost-effective and environmental friendly solutions to reduce the adverse effect of pulp and paper sludge disposal.

For more information:
cetc-varennes.nrcan.gc.ca/en/indus.html

Industrial Processes and Technologies: Industry Energy Research and Development (IERD) Program

Objective: To encourage and support the development and application of leading-edge, energy-efficient and environmentally responsible processes, products, systems and equipment in industry.

Financial support is provided for commercially confidential applied research and development (R&D) activities, which is repayable if the project is commercially successful. Program clients from all industrial sectors range from small- and medium-sized companies to multinational corporations.

Key 2004–2005 Achievements

- Assist Synodon Inc. of Edmonton in developing realSens™ technology for high-speed aircraft to accurately sense natural gas leaks in pipelines. Currently, five million kilometres of pipelines are regularly tested by inspectors with hand-held sensors. By enabling aircraft to remotely pinpoint minute leaks of natural gas, realSens™ will reduce inspection costs, increase safety and reliability, and control fugitive emissions of natural gas – a waste of energy and a potent greenhouse gas.
- With the financial support of IERD, Marine Exhaust Solutions Inc. of Prince Edward Island is demonstrating the EcoSilencer™, a marine engine exhaust gas scrubber. It removes significant amounts of sulphur dioxide and particulate matter, as well as reduces the noise level from the exhaust, and meets anticipated European Union marine emissions regulations. The unit is amenable to heat recovery for on-board use, thereby reducing energy use and GHG emissions by as much as 10 percent.
- Turbocor Inc. of Montréal is developing a new compressor and refrigeration rack for supermarket counter refrigeration. This refrigerator is designed to reduce energy consumption by 30 percent. Projections show that the energy savings generated worldwide by this technology could attain 28 petajoules per year and associated GHG emission reduction of over 1 million tonnes per year by 2015.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/factsheet_industry_energy_research_and_development_program_e.html

Industrial Processes and Technologies: Emerging Technologies Program (ETP)

Objective: To support the identification and demonstration of new and emerging energy-efficient technologies.

Projects are co-managed and cost-shared with industry and other stakeholders, such as gas and electric utilities, other governments and equipment manufacturers. Financial support is provided for the development and testing of pilot plants, prototypes and full-scale field trials to evaluate operating performance, energy efficiency and environmental impacts. NRCan's financial support is repayable from any cost savings or revenues realized from a project.

Key 2004–2005 Achievements

- With the financial support of the ETP, Cambior Inc.'s Niobec Mine of Saint-Honoré-de-Chicoutimi, Quebec, and Hydro-Québec are designing and demonstrating a high-efficiency electrical-induction ore-concentrate dryer to replace the current oil-fired dryer. This will reduce energy consumption and GHG emissions.
- The ETP contributed to in-plant testing of a ceramic heat recovery unit in the flue of a zinc oxide furnace by G.H. Chemicals Ltd. of Saint-Hyacinthe, Quebec, and the Natural Gas Technology Centre, Boucherville, Quebec. The resulting 20 percent energy savings has justified installation of the heat recovery unit on four more furnaces with plans for installation on all 20 furnaces at the G.H. Chemicals' plant.
- Westport Innovations Inc. of Vancouver, British Columbia, has completed an ETP-sponsored one-year field trial of its high-efficiency, direct-injection natural gas engine for stationary power generation, at a water/wastewater treatment facility in Grande Prairie, Alberta. GHG emissions were reduced by 26 percent compared with the Alberta electrical grid and 21 percent compared with a diesel generator.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/funding_programs_etp_e.html

Industrial Processes and Technologies: Industrial Energy Innovation

Objective: To assist major industrial energy consumers to reduce the energy intensity of their operations and to reduce GHG emissions, by-product emissions of CO_2 and other GHGs.

Industrial combustion processes are the major sources of industrial GHG emissions. Because they operate at low thermal efficiencies of 30 to 50 percent, there are major opportunities to improve industrial energy efficiency and productivity while significantly reducing GHG emissions.

CETC's work in this area includes changing the interaction of the combustion system with the process with advanced tools and technologies. As well, together with the Large Final Emitters Group and the Office of Energy Efficiency, CETC held technical workshops with major industry sectors (steel, mining, smelting and refining, cement, lime, and pulp and paper) and with CIPEC, industrial associations and individual companies to help define and map partnerships for a generic industrial combustion R&D program and applications to take advantage of these opportunities, with potential energy and GHG reductions of 10 to 40 percent. In addition, it is engaged in developing generic tools and technologies that cross industry sectors, fuels and furnaces.

Key 2004–2005 Achievements

- Application of state-of-the-art burner technologies to industrial processes. High Temperature Air Combustion (HTAC) technology has the potential to reduce natural gas use by as much as 50 percent in steel heating processes and maintain ultra-low nitrogen oxide emissions. This will reduce GHG emissions. The Industrial Energy Innovation program has been active in this area, presenting eight workshops to steel companies and developing project descriptions for two research consortia for HTAC technology development. As well, it received four written expressions of interest in these consortia, prepared a business plan to include the consortia and the installation of a Pilot-Scale Research Industrial Furnace at CETC–Ottawa, and prepared reports on the cost benefit analysis of the HTAC technology in steel furnaces.
- Jointly with Large Final Emitters, conducted one- to two-day workshops at CETC–Ottawa with each major industrial energy-intensive sector – steel, mining and smelting, refining, cement, lime, pulp and paper – to develop technical roadmaps to define and achieve industry R&D needs and goals.
- Developed and tested a software tool, EFFECC (Efficiency Evaluation and Combustion Calculation Tool), that can be installed on any computer and easily used by engineers or consultants doing combustion energy evaluations. This software promptly identifies efficiency opportunities, as well as major heat losses that can cause excessive GHG emissions due to incomplete combustion, heat transfer and exhaust of combustion products.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_e.html

Industrial Processes and Technologies: Minerals and Metals Program

Objective: To reduce GHG emissions from Canada's minerals and metals sector by enhancing mineral and metal recycling processes and practices, by encouraging replacement of cement in concrete by supplementary cementing materials (SCMs), and by assessing alternate production processes.

The Minerals and Metals Program is a component of the *Government of Canada Action Plan 2000 on Climate Change* managed by CANMET Mineral Technology Branch. It has a GHG emissions reduction target of 1.65 million tonnes of CO_2 equivalent per year, by 2010. It consists of 1) the Enhanced Recycling program that aims to increase Canada's potential to recycle all materials by developing new approaches and improving upon existing recycling infrastructure, practices and policies; and 2) the Enhanced Emission Reductions for Minerals and Metals program, which supports activities that will increase the use of SCMs in concrete to replace portland cement (thereby reducing the GHG emissions of concrete production) and which examines processes where improved understanding can lead to new emission-reduction opportunities in the minerals and metals industry sector.

Key 2004–2005 Achievements

- The Enhanced Recycling program raised awareness of many important issues among a broad group of stakeholders across Canada, especially at the municipal and regional level, through participation in various communications opportunities. Other activities included completion of a project to characterize construction and demolition wastes, and significant progress on a pilot project to examine the feasibility of adding scrap metal to a residential blue box collection program.
- CANMET's Materials Technology Laboratory completed the development of a user-friendly tool for contractors wanting to use SCMs in their construction projects.
- In partnership with stakeholders, several projects were undertaken to demonstrate the viability of and resolve technical issues associated with SCM use in different applications.

For more information:
recycle.nrcan.gc.ca/default_e.htm

nrcan.gc.ca/mms/canmet-mtb/mtl/research/concrete_e.htm

Industrial Processes and Technologies: Mine Ventilation

Objective: To reduce energy consumption and GHG emissions associated with mine ventilation through infrastructure automation (to support demand-based delivery systems), ventilation network optimization and management, and less air-volume demanding technology.

Mine ventilation systems that were traditionally designed to operate at maximum flow (peak production 24 hours a day, 7 days a week) are being adjusted to match actual production needs. Ventilation is required in underground mines to maintain a safe working environment by diluting and removing harmful pollutants (dusts and gases) and providing a thermally suitable working climate. Providing sufficient and suitable ventilation can account for 40 percent of the energy consumed underground by a mining operation. Energy savings at less than peak demand range from linear for the heating/cooling systems through to a cubic relationship for the primary fan system. However, optimizing energy use is not straightforward, as it depends on the specific consumption profile (i.e. electricity versus heating fuels and primary versus secondary delivery systems) for each mine and requires evaluation on a case-by-case basis.

Key 2004–2005 Achievements

- In order to assess potential cost, energy requirements and GHG-reduction strategies, CANMET – Mining and Mineral Science Laboratories investigated process-based modelling of ventilation needs as a function of the life of the mine. This will enable mine management to select the level of ventilation that is appropriate to support production and to dilute contamination, on an on-demand basis. The models are expected to be available by 2006.
- The case study for the implementation of ventilation on demand at an Inco mine continues. The first phase monitored activity and revealed that some ventilation infrastructure operates needlessly for long periods of time. Logging of energy demands associated with ventilation as a function of production cycles is ongoing. In the next phase, modelling will enable Inco to evaluate, through a business case, the ventilation control options that can result in providing air as it is needed.

For more information:
nrcan.gc.ca/mms/canmet-mtb/mmsl-lmsm/mines/air/air-e.htm

Chapter 6: Transportation

Energy Use and Greenhouse Gas Emissions

The transportation sector consists of three sub-sectors: passenger, freight and off-road. Passenger and freight transportation accounted for 56.0 percent and 40.1 percent, respectively, of transportation energy use, with off-road representing only 3.9 percent in 2003. The passenger sub-sector is composed of three modes: road, rail and air. The freight sub-sector, as defined by Natural Resources Canada (NRCan), is composed of road, rail, air and marine. Road transport uses the most energy, accounting for 79.0 percent of total transportation energy use in 2003. Of this amount, 59.4 percent was passenger energy use and 40.6 percent was freight energy use (see Figure 6-1).

All NRCan transportation energy-use programs focus on the energy used in road transportation. Total transportation energy use increased by 25.7 percent (483 petajoules) over 1990 to 2003 (see Figure 6-2). Passenger transportation energy use increased by 15.1 percent (173 petajoules), while freight transportation energy use increased by 40.1 percent (271 petajoules).

Three main factors influenced energy use:

- activity – due to increases in population and economic activity, there was greater transportation activity (measured as passenger-kilometres for passenger transportation and tonne-kilometres for freight transportation). This increased transportation energy use by 33.2 percent (592 petajoules). The freight and passenger segments contributed to this increase by 51.1 percent and 48.9 percent, respectively.
- structure – shifts between modes of transport within both the freight and passenger segments resulted in an increase of 8.1 percent in transportation energy use (144 petajoules). The effects of mode shifting were more pronounced in the freight segment since freight truck activity is growing significantly faster than rail and marine.
- energy efficiency – improvements in energy efficiency worked to decrease energy use by 15.7 percent (280 petajoules).

Without improvements in energy efficiency, increases attributable to activity and structure would have led to an increase in transportation energy use of 41.2 percent (736 petajoules). However, as a result of improvements in energy efficiency, actual energy use increased by 25.7 percent. This change in energy use between 1990 and 2003, as well as the estimated energy savings due to energy efficiency, is shown in Figure 6-2.

FIGURE 6-1

Transportation Energy Use by Mode, 2003

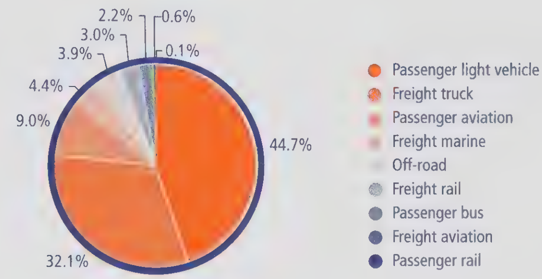
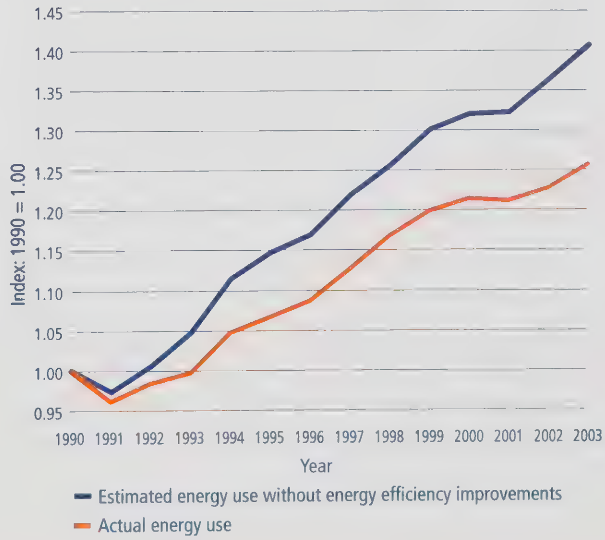


FIGURE 6-2

Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003



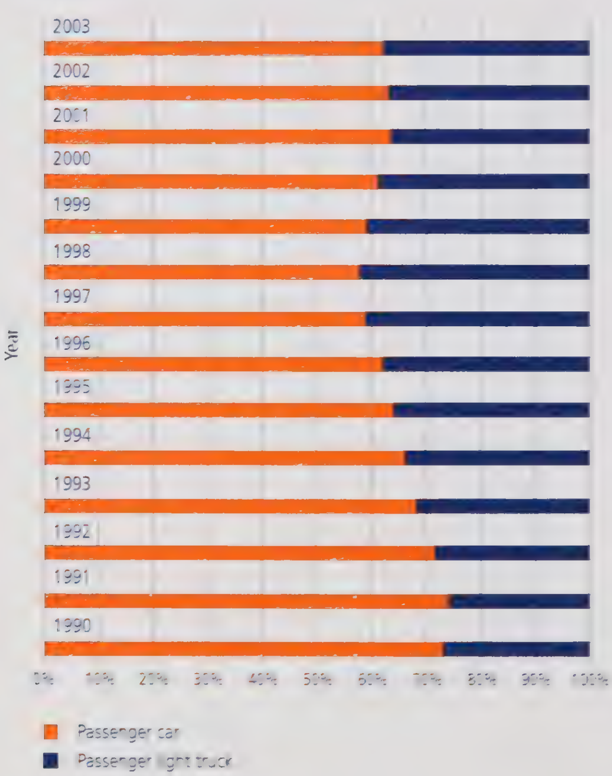
The transportation sector accounts for 27.9 percent (2361 petajoules) of secondary energy use and 33.6 percent (169 megatonnes) of greenhouse gas (GHG) emissions. From 1990 to 2003, transportation energy use increased by 25.7 percent, and GHG emissions increased by 25.0 percent. The change in GHG intensity of transportation energy use was negligible.

Figure 6-3 shows how the market share of new light trucks increased in the 1990s, reflecting the growth in popularity of minivans and sport-utility vehicles. Figure 6-4 demonstrates that, on a per-kilogram or per-unit-of-horsepower basis, fuel efficiency has improved markedly. However, average fuel economy has been stable because new vehicles continue to be heavier and have more powerful engines.

Figure 6-5 illustrates an improvement in trucking energy intensity despite an increase in average activity over 1990 to 2003. Improved fleet practices, caused by an increase in the competitiveness of the transportation sector and by the introduction of electronic engines, have significantly improved engine fuel efficiency in medium-duty and heavy-duty trucks.

FIGURE 6-3

Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2003



NRCan delivers initiatives in the following areas to increase the efficiency of motor vehicles and encourage the use of alternative fuels:

- vehicles
- transportation research and development
- alternative transportation fuels
- transportation technologies

FIGURE 6-4

New Car Fuel Efficiency, Normalized for Weight and Power, 1990 to 2003

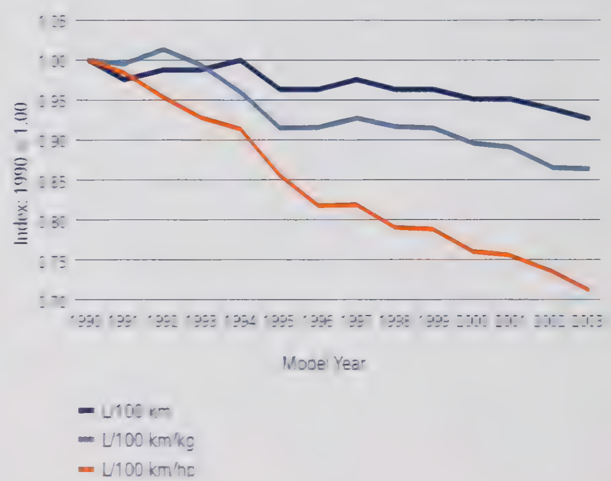
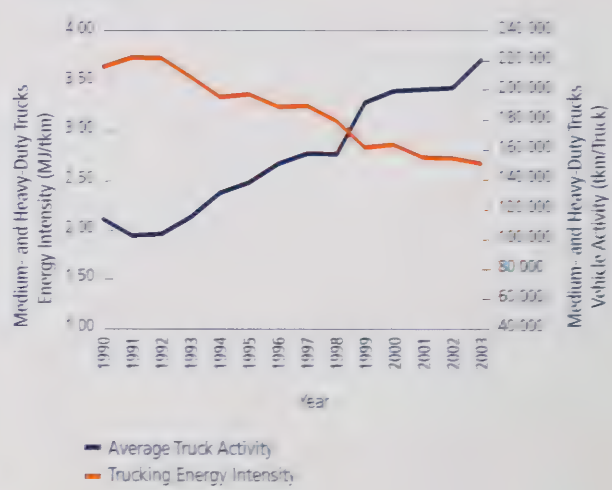


FIGURE 6-5

Trucking Energy Intensity and Average Activity per Truck, 1990 to 2003



Vehicles: Vehicle Efficiency

Objective: To improve the fuel efficiency and reduce the GHG emissions of new light-duty vehicles sold in Canada.

The Motor Vehicle Fuel Efficiency Initiative is intended to bring about a 25 percent improvement in the fuel efficiency of new light-duty vehicles sold in Canada by 2010. NRCan has led negotiations with the automotive industry to a successful conclusion, reaching an agreement to reduce GHG emissions from this sector. The auto industry committed to a voluntary reduction in GHG emissions of 5.3 megatonnes (Mt) annually from light-duty vehicle use by 2010. This 5.3-Mt target exceeds the GHG emissions reductions being sought under the 25 percent target, by going beyond fuel consumption reductions and incorporating reductions in all GHG emissions associated with vehicle use.

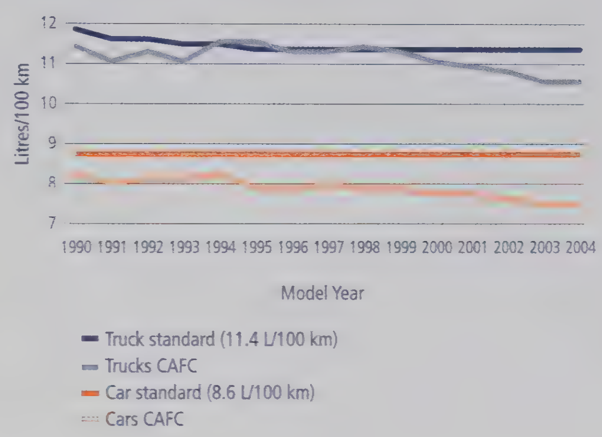
Key 2004–2005 Achievements

- Researched and analysed the level of effort and the cost implications to auto manufacturers of meeting the 25 percent target, based on different agreement types; analysed the sensitivity of fuel consumption to market shifts between different vehicle segments.
- Completed a joint study, between NRCan and U.S. Department of Energy, on the future potential of hybrid and diesel powertrains in the North American light-duty vehicle market.
- Completed negotiations with industry and finalized a Memorandum of Understanding to reduce GHG emissions from light-duty vehicles in Canada by 5.3 Mt by 2010.

For more information:
oee.nrcan.gc.ca/transportation/fuels/motorvehicles.cfm

FIGURE 6-6

Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards, 1990 to 2004



Vehicles: EnerGuide for Vehicles

Objective: To improve motor vehicle fuel efficiency by encouraging private motorists to purchase energy-efficient vehicles.

EnerGuide for Vehicles promotes the purchase of fuel-efficient vehicles in order to reduce vehicle emissions and mitigate other vehicle-related environmental impacts. It offers a series of tools to help Canadian motorists consider fuel efficiency in their vehicle purchase decisions, and encourages buyers to choose the most fuel-efficient vehicle that meets their everyday needs.

Each year, the free *Fuel Consumption Guide* provides fuel consumption ratings and the estimated annual fuel cost, fuel consumption and carbon dioxide (CO_2) emissions for new passenger cars, light-duty pickup trucks, vans and special purpose vehicles sold in Canada. The EnerGuide label, which is affixed on the side window of new light-duty vehicles sold in Canada, provides specific fuel consumption information for each model. Every year, the EnerGuide for Vehicles Awards recognize the most fuel-efficient vehicles in nine categories. Awards are presented to the manufacturers.

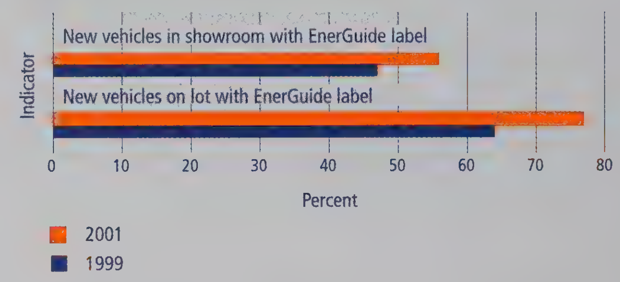
NRCan is also developing a New Vehicle Ranking System to provide a visible signal directing consumers and fleets to the purchase of fuel-efficient and low-CO_2-emitting vehicles.

Key 2004–2005 Achievements

- Attended major Canadian Auto Shows to highlight the impact of personal transportation on GHG emissions and to promote the purchase of energy-efficient vehicles. In particular, in collaboration with the One-Tonne Challenge, a new exhibit was launched at the Canadian International Auto Show in Toronto, Ontario, with the overall message for consumers: "*You're in the Driver's Seat, Making Smart Choices About Your Transportation.*"
- Distributed 300 000 copies of the 2005 *Fuel Consumption Guide* and tabletop display to 1189 Canadian Automobile Association retail offices, 3500 dealerships and other outlets across Canada.
- Initial consultations have occurred with stakeholders to discuss options for the New Vehicle Ranking System (NVRS). Research has been completed to identify key target audiences for marketing the NVRS.

FIGURE 6-7

Vehicle Fuel Efficiency Awareness – EnerGuide Labels



For more information:
oee.nrcan.gc.ca/vehicles

Vehicles: Personal Vehicles

Objective: To improve motor vehicle fuel efficiency by encouraging private motorists to develop energy-efficient vehicle use and maintenance practices.

Personal Vehicle information initiative promotes improving vehicle fuel efficiency in order to reduce vehicle emissions and mitigate other vehicle-related environmental impacts. The program helps motorists understand how driving and maintenance behaviours affect climate change and the environment. It encourages Canadians to adopt fuel-efficient driving techniques and maintenance practices. This initiative complements EnerGuide for Vehicles.

Key components include the newly launched Auto$mart "A New Point of View" Driver Educator kit, which provides instructors with the instruments (instructor's in-class materials, student workbook, instructor's in-car guide, video, CD-ROM, student tips cards, and fuel consumption calculator) to teach fuel-efficient driving to drivers; the Idle-Free Campaign, which seeks to curb vehicle idling; and the Be Tire Smart Campaign developed in collaboration with the Rubber Association of Canada, which seeks to have Canadians adopt good tire maintenance and inflation practices. Recently the initiative has been working in collaboration with Transport Canada to explore the potential for developing a program to encourage Canadian motorists to adopt good speed-management practices.

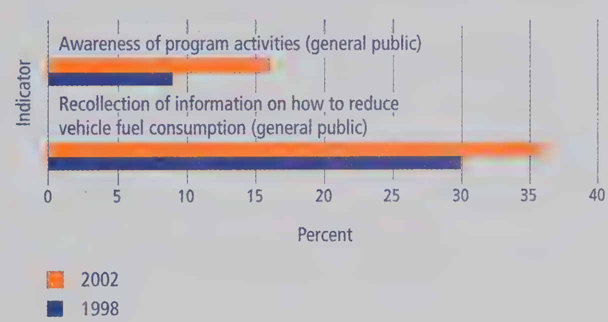
Key 2004–2005 Achievements

- Successfully launched a new driver educator program developed through stakeholder consultations (provinces, Canada Safety Council, Transport Canada, Road Safety Educators' Association, and driving school associations). Key achievements include the development of a phase-in approach to provincial driver training and examination; the revision of the Auto$mart Student Driver Kit to a driver educator-based Auto$mart "A New Point of View" Driver Educator kit; and the training of master trainers who are currently providing training to Canadian driving instructors on how to incorporate the materials into their existing curricula.
- Successfully completed an idling campaign with Better Environmentally Sound Transportation in the Greater Vancouver Regional District. Initiated multi-year collaborative agreements with the Clean Air Partnership and Halifax Regional Municipality to review and develop regulatory and voluntary approaches to idling behaviour and to conduct an Idle-Free campaign, respectively.
- Launched a national level "Be Tire Smart Week" and conducted regional campaigns in Quebec and British Columbia.

For more information:
vehicles.gc.ca

FIGURE 6-8

Vehicle Fuel Efficiency Awareness – Program Activities



Vehicles: Fleet Vehicles

Objective: To improve the fuel efficiency and reduce the GHG emissions in commercial and institutional road transportation fleet operations and all other non-Government of Canada vehicle fleets through energy efficiency practices and the use of alternative fuels.

Fleet Vehicles provides information materials, workshops, technical demonstrations, driver training programs and special projects, such as the truck stop Idle-Free – Quiet Zone Campaign, to help fleet operators assess and pursue opportunities to increase energy efficiency in their operations. To increase market penetration of fuel-efficient and emission-reduction technologies, the Fleet Vehicles initiative also provides financial incentives to commercial fleets purchasing pre-selected anti-idling technologies and natural gas vehicles. NRCan delivers the Fleet Vehicles initiative in partnership with fleets, industry stakeholders and other levels of government.

Key 2004–2005 Achievements

- To date, the Fleet Vehicles initiative has registered over 3625 members. The annual truck stop Idle-Free – Quiet Zone Campaign was successfully conducted at more than 80 sites across Canada.
- A third driver-training curriculum has been added to the SmartDriver family of tools, SmartDriver for Transit. More than 200 000 new and experienced commercial drivers have been trained in highway and forestry trucking and the transit industry.
- The Commercial Transportation Energy Efficiency Rebate (CTEER) initiative has increased market penetration in its second year of existence. This initiative has provided more than $2.8 million in incentives, an increase of 235 percent in comparison to 2003–2004.
- Natural gas industry partners are piloting EPA-certified compressed natural gas conversion kits for light-duty vehicles and a Liquified Natural Gas Diesel engine for commercial trucking.

For more information:
fleetsmart.nrcan.gc.ca

FIGURE 6-9

Drivers Trained and Participation in the Fleet Vehicles Initiative 1997–1999 to 2003–2004

Transportation Research and Development: Canadian Lightweight Materials Research Initiative (CliMRI)

Objective: To develop low-density, high-strength, lightweight materials to achieve weight reductions in ground transportation vehicles.

CLiMRI is a research network comprising 29 companies, eight universities and seven government departments and funding agencies. CLiMRI's goal is to develop and implement lightweight and high-strength materials in transportation applications for the purposes of (a) reducing GHG emissions through vehicle weight reduction and improving vehicle efficiency, and (b) enhancing the competitiveness of Canadian primary metals producers, automotive part manufacturers and suppliers.

Key 2004–2005 Achievements

- Magnesium is one of the lightest of all metals, but its use in automotive applications is currently limited to die-cast parts because of difficulties in producing magnesium in sheet form. CANMET-Materials Technology Laboratory (MTL) has developed a technique to simulate the twin-roll strip casting of magnesium sheet, and the material's performance is being assessed. Additionally, sand- and permanent-mould casting processes were optimized to produce high-integrity castings. These achievements show significant potential for increasing the use of magnesium in the automotive industry.
- Unlike aluminum, magnesium is prone to corrosion in the presence of chlorides such as road de-icing salt. Corrosion control is therefore a key enabling technology that will lead to wider-scale use of magnesium in automobiles. As part of a larger research program with the U.S. Department of Energy and automakers, CANMET-MTL is leading the corrosion control and coating assessment research for magnesium alloys. Environmentally friendly coatings were selected, and a new material was developed for spacer and washer applications between corrosion-prone areas. The team also helped automakers to prevent premature failures related to metal creep and corrosion fatigue, and contributed to the production of a magnesium engine cradle for the 2006 GM Corvette.
- Recent developments in hydroforming, a metal-shaping process that uses gas or water at high pressures to form tubes of sheet metal, have enabled significant productivity gains and weight reductions for complex structural automotive components. CANMET-MTL is working to extend the commercial use of hydroforming from conventional low-carbon steel to lightweight metals and ultra-high-strength steels. To achieve this goal, a suitable seam-welding process to join tubes made of these materials was developed. Prototype aluminum and high-strength steel tubes were successfully produced for evaluation by clients, and the team demonstrated that magnesium tubes can be shaped to make parts. Furthermore, the team demonstrated that the CANMET-MTL tube-forming method can produce tubes that exceed the quality of many other laboratories and industries in the United States and Europe.

For more information:
climri.nrcan.gc.ca/default_e.htm

Transportation Research and Development: Fuel-Cell-Powered Mining Vehicles

Objective: To develop the technology to replace diesel power by hydrogen fuel cell power in underground mining vehicles.

NRCan has taken a co-leadership role in the North American Consortium for Fuel-Cell-Powered Mining Vehicles. Hydrogen fuel cell power systems are more efficient in delivering power than conventional diesel equipment. Retrofitting diesel-powered vehicles with hydrogen fuel cells should improve vehicle productivity, operating costs and the work environment for underground miners by eliminating toxic underground diesel emissions and by reducing heat and noise. Fuel cells have also been shown to have the potential to significantly reduce CO_2 or GHG emissions by up to one million tonnes per year (26 percent of the total CO_2 equivalent emitted by the mining extraction sector) and decrease operating costs by lowering mine ventilation needs.

Key 2004–2005 Achievements

- Reliability studies for the 4-tonne fuel cell locomotive in the underground environment were completed. Fine-tuning of the power plant improved overall efficiency and reduced operational constraints.
- The developmental project for the fuel cell underground mine loader is now at the power plant assembly stage and will follow with initial performance tests in an industrial environment by the end of 2005.
- An agreement in principle was reached for the development of a fuell cell underground light-duty mining vehicle, as well as a water electrolysis unit for hydrogen production. Light-duty mining vehicles are considered to be the most polluting of all the underground diesel mining vehicles.

For more information:
nrcan.gc.ca/mms/canmet-mtb/mmsl-lmsm/mines/mines-e.htm

Alternative Transportation Fuels: Future Fuels Initiative

Objective: To increase Canada's fuel ethanol production and use in the transportation sector.

The Future Fuels Initiative, co-managed with Agriculture and Agri-Food Canada, targets motorists, provinces and territories, and renewable fuel producers. The main activities under this initiative are public awareness campaigns, federal-provincial policy co-ordination, industry consultation and analytical work on feedstocks, production costs, greenhouse gas and socio-economic impacts. Additionally, the Initiative includes the National Biomass Ethanol Program, administered by Farm Credit Canada, which aims to overcome lender resistance to investing in ethanol plants due to the uncertainty of future excise tax policy.

Key 2004–2005 Achievements

- Completed detailed study that examined the factors affecting the success of the renewable fuels industry in Canada and presented the results via a workshop to industry, provincial and territorial officials and other stakeholders.
- Developed new public awareness materials for distribution to motorists via fuel distributor partners and other channels.
- Extended GHG emission and energy use modelling capabilities and contributed to important emission and health impact studies.

For more information:
vehiclefuels.gc.ca

Alternative Transportation Fuels: Ethanol Expansion Program

Objective: To expand fuel ethanol production and use in Canada.

The Ethanol Expansion Program, co-managed with Agriculture and Agri-Food Canada, targets existing and potential fuel ethanol producers and supports the climate change plan goal of having 35 percent of Canadian gasoline contain 10 percent ethanol by 2010. The program provides contributions towards the construction of new fuel ethanol production facilities through a competitive solicitation process. Selection criteria measure the ability of projects to maximize ethanol production and use and reduce transportation GHG emissions. Additionally, the program is investigating how to develop a successful commercial cellulose-based ethanol industry in Canada (i.e. ethanol produced from agricultural residues or wood).

Key 2004–2005 Achievements

- Executed contribution agreements totalling $72 million for six new ethanol plants across Canada. These projects, for which investments total almost $0.5 billion, plan to produce over 650 million litres of fuel ethanol per year and more than quadruple Canadian supply by the end of 2006.
- Launched the second round of the program in December 2004, and commenced the evaluation of plant proposals that were received from across the country pursuant to the February 2005 deadline.
- Continued consultations with stakeholders regarding cellulosic ethanol industry development.

For more information:
vehiclefuels.gc.ca

Alternative Transportation Fuels: Biodiesel Initiative

Objective: To support increased biodiesel production and use in Canada's transportation sector.

The Biodiesel Initiative supports the Government of Canada's proposed target of 500 million litres of biodiesel production per year by 2010. The main components of this initiative are research and development, technical and socio-economic studies, end-use demonstrations and testing, stakeholder education and standards development.

Key 2004–2005 Achievements

- Developed national fuel quality specifications for 1 to 5 percent biodiesel blends and continued work on standardization of fuel quality and content on B-2, B-5, B-20 blends and B-100 emissions analysis, fuels specifications and fuel property analysis.
- Completed marine demonstration consisting of 12 cruisers running on various blends of biodiesel.
- Contributed to biodiesel plant feasibility studies across Canada as well as information dissemination to industry stakeholders.

For more information:
vehiclefuels.gc.ca

Transportation Technologies: Canadian Transportation Fuel Cell Alliance

Objective: To demonstrate and evaluate different processes for the production and delivery of hydrogen to fuel cell vehicles at fuelling stations and to participate in the development of codes and standards.

The Canadian Transportation Fuel Cell Alliance (CTFCA) is a private-public sector initiative composed of technology developers, fuel providers, auto manufacturers, federal and provincial/territorial governments, academia and non-governmental organization representatives. The CTFCA's work contributes to a reduction in GHG emissions by encouraging advancements in hydrogen and fuel cell technologies through demonstration projects that evaluate the technical, economic and environmental feasibility of different hydrogen fuelling options for fuel cell vehicles. The initiative also establishes a supporting framework for hydrogen fuelling by assisting in the development of codes and standards as well as certification and training programs.

Key 2004–2005 Achievements

- Initiated the construction of three of the "Hydrogen Highway" fuelling stations in British Columbia and took receipt of five Ford Focus fuel cell cars for three years of on-road testing and evaluation in the Vancouver and Victoria areas.
- Documented the regulatory development process in Canada as it relates to hydrogen standards, developed an emergency response guide for hydrogen vehicles and hydrogen fuelling stations, completed a study of the scientific principles used in the development of safety factors used in the design of hydrogen stations, and produced a Web-based computer model for the virtual design of hydrogen fuelling stations.
- Expanded the capability of NRCan's GHGenius model used to evaluate the GHG and criteria air contaminant emissions, on a life-cycle basis.

For more information:
nrcan.gc.ca/es/etb/ctfca/index.html

Transportation Technologies: Hydrogen, Fuel Cells and Transportation Energy Program

Objective: In partnership with industry, to develop and deploy leading-edge hydrogen and transportation technologies that reduce GHG emissions, minimize other environmental impacts, increase the potential for job and economic growth and extend the life span of Canada's energy resource base.

Program staff work with stakeholders in the domestic and international hydrogen and transportation industries, including original equipment manufacturers, industry associations, fleet managers, transit authorities, utilities, provincial and territorial governments, research organizations, universities, other federal departments, the U.S. Department of Energy and the International Energy Agency.

Highlights of Hydrogen, Fuel Cells and Transportation Energy Program's work include

- Supporting Canadian industry in developing a world-leading water electrolysis technology for the production of hydrogen from clean renewable energy sources.
- Working in partnership with Canada's fuel cell industry over the last 20 years, which has established Canada as a world leader in fuel cell and refuelling technologies; for example, the world's first hydrogen fuel cell bus was demonstrated in Canada.
- Supporting student vehicle challenges since the 1980s, and bringing university and college students from across North America together with automotive manufacturers to modify existing vehicles to run on a variety of alternative fuels.
- The program has also supported the development of alternative transportation fuel technologies, for example, for natural gas and propane vehicles, which has led to a Canadian industry that is now exporting commercial products.

Key 2004–2005 Achievements

- Organization and sponsorship of world-class conferences, including the Windsor Workshop and the 2004 Canadian Hydrogen and Fuel Cells Conference and Trade Show.
- Development of hydrogen compressor based on metal hydrides to increase efficiency of gas compression.
- Support for Future Truck Student Challenge, in conjunction with the U.S. Department of Energy and the Ford Motor Company, to assist students in designing and implementing alternative fuel technologies.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/programs_tet_e.html

Chapter 7: Renewable Energy

Renewable Energy Use

In 2003, renewable energy generation capacity from renewable sources accounted for approximately 62 percent of total Canadian electricity capacity (see Table 7-2). Most of the renewable energy used in Canada comes from either hydro-electricity or thermal energy from biomass such as wood-waste sources.

Hydro-Electricity

Hydraulic power is a renewable energy based on the water cycle – evaporation, precipitation and flow of water toward the ocean. Canada has abundant water resources, and its geography provides many opportunities to produce low-cost energy. Tapping the energy from moving water has played an important role in the economic and social development of Canada for the past three centuries.

In 2003, hydro power accounted for about 60 percent of total electricity generation. Small-scale hydro-electric projects, with a capacity of 20 megawatts (MW) or less, constitute about 4 percent of Canada's electricity-generating capacity. Small-scale hydro has good potential for increased production.

Biomass

Bioenergy is a renewable source of energy derived from organic substances known as biomass. Biomass is supplied by agricultural wastes (such as chaff, straw, grain screenings, husks and shells, food-processing residues and methane) and forestry wastes (such as logging slash, sawdust, black liquor from the pulping process and other industrial waste). Other biomass supplies include animal litter and manure, landfill gas methane, urban wastes to be incinerated and sewage for biogas. Bioenergy contributes about 6 percent of Canada's primary energy, mostly for industrial process heat, electricity generation and residential space heating. Corn and other agricultural products are also used to generate ethanol and biodiesels for the transportation market.

TABLE 7-1

Renewable Energy Markets and Technologies Used in Canada

Electricity	*Thermal Energy*
Hydro-electricity	Biomass (e.g. roundwood, pellets, wood chips)
Tidal power	Ground-source heat pumps (e.g. earth energy)
Biomass (e.g. wood waste)	Solar air-heating systems
Biogas (e.g. methane from landfill sites)	Solar hot-water systems
Wind turbines	
Photovoltaic systems	
Mechanical Power	*Transportation*
Wind water pumps	Biodiesel
	Ethanol from biomass

TABLE 7-2

Electricity Generation Capacity From Renewable Sources (Includes Hydro)

Year	*Renewable electricity generation capacity (MW)*	*% of total capacity*
1990	59 557	58
1991	61 116	58
1992	62 895	58
1993	63 114	56
1994	63 175	56
1995	66 542	57
1996	67 101	59
1997	68 202	61
1998	68 340	62
1999	68 686	62
2000	69 005	62
2001	68 734	61
2002	70 895	62
2003	72 160	62

Bioenergy production represents Canada's second largest renewable energy source. Most bioenergy is produced from organic refuse and used with the facilities in which the energy conversion takes place. The pulp and paper industry produces and uses most of Canada's bioenergy. Industrially produced heat and electricity, independent power producers' electricity, electricity from urban wastes and residential wood heat are all considered commonplace in Canada's energy mix.

Home heating with wood usually takes the form of stand-alone wood stoves, wood furnaces with hot-water or forced-air systems, fireplaces with advanced combustion inserts, high-efficiency fireplaces or high-thermal-mass masonry heaters. About 3 million Canadian households use wood for home heating. Canadians usually prefer round-wood, but alternatives include wood chips and pellets.

Earth Energy

As a result of the sun heating the surface of the planet, the temperature of the earth that is one or two metres below the surface remains fairly constant – between 5°C and 10°C. This is warmer than outside air during the winter and cooler than outside air during the middle of summer. A ground-source heat pump takes advantage of this temperature difference by using the earth or the ground water as a source of heat in the winter and as a "sink" for heat removed from indoor air in the summer. For this reason, ground-source heat pumps are known as earth energy systems (EESs).

During winter, EES installations remove heat from the earth using a liquid, typically an antifreeze solution, that circulates within an underground loop. It then upgrades the heat with a conventional heat pump and transfers it to indoor space or the water-heating system. During summer, the system reverses this process to operate as an air conditioner. EES installations supply less than 1 percent of the market for space and water heating and cooling in Canada.

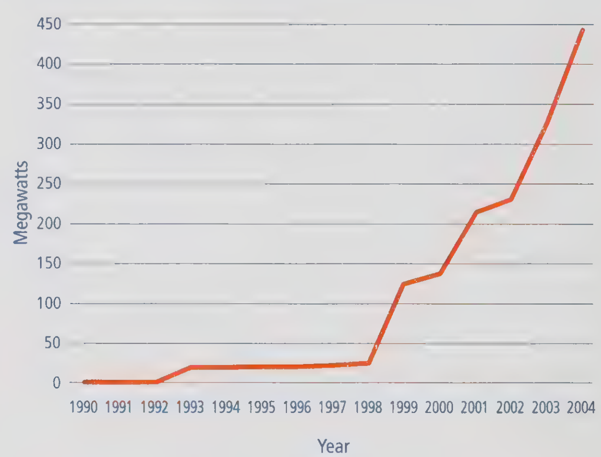
Wind Energy

Wind turbines convert the kinetic energy of wind into electrical or mechanical energy. Canada has a large wind resource potential because of its large size and northern location. A 1992 study by Natural Resources Canada (NRCan) estimated the technical wind energy potential in Canada at about 28 000 megawatts. If developed, this could supply 11 percent of total Canadian electricity consumption. In 2004, wind energy accounted for less than 1 percent of Canada's total electricity generation (see Figure 7-1).

Wind energy also provides mechanical power. Several thousand wind-powered water pumps are used throughout Canada, mostly in the Prairie provinces. As well, Canadians use small, residential-sized wind turbines to power cottages and remote houses.

FIGURE 7-1

Canadian Wind Power Capacity, 1990 to 2004



Solar Energy

Three main technologies use energy from the sun:

- passive solar technologies is a term that means buildings are designed and located to maximize their reception of solar energy.
- active solar thermal systems convert solar radiation into thermal energy for heating air or water in residential, commercial and industrial applications.
- solar electric (photovoltaic) systems use solar radiation to produce electricity.

During the 1990s, NRCan assisted a Canadian company in developing a perforated solar absorber to preheat ventilation air and reduce a building's fuel requirements for space heating. This technology is more cost-effective than conventional solar air-heating technologies and is gaining acceptance in Canada and abroad. Systems have been installed on industrial and commercial/institutional buildings throughout Canada.

Canada's total photovoltaic (PV) power installed capacity increased by 18 percent in 2004 to 14 MW compared to 11.8 MW at the end of 2003. Total PV module sales in Canada (domestic and export) were at 2.14 MW. The average market growth has been 23 percent annually since 1992. In 2004, jobs grew by 24 percent to 765 positions with total revenues estimated at CAN$125 million, a 25 percent increase over 2003. The Spheral Solar Power Inc. facility opened in June 2004. This resulted in an increase in R&D investments by manufacturers up 300 percent in 2004 reaching CAN$30 million. The price of PV modules dropped to CAN$5.53 per watt in 2004, with a steady average decline of 12 percent per year since 1999.

Canada's commitment in 2004 to ratifying the Kyoto Protocol made possible the funding of climate change programs that have benefited PV. There has been a 15 percent increase in the total public (federal and provincial combined) R&D and demonstration budget that reached CAN$9.8 million in 2004. This funding focused on technology and innovation with a 2025 horizon.

NRCan delivers several initiatives to increase the use of small-scale renewable energy in Canada. The following is the array of NRCan renewable energy programs.

Renewable Energy Programs: Initiative to Purchase Electricity From Emerging Renewable Energy Sources

Objective: To purchase electricity from emerging renewable energy sources (ERES) that are certified by a third party as having low environmental impact, with the objective of reducing greenhouse gas (GHG) and other air pollution emissions associated with federal electricity consumption.

Between 1998 and 2001, NRCan entered into three pilot projects to purchase electricity from ERES for federal facilities in Alberta, Prince Edward Island and Saskatchewan. The Government of Canada has pledged to purchase 20 percent of its electricity from ERES by 2010.

Key 2004–2005 Achievements

- The Government of Canada received its third full year of electricity from ERES in Saskatchewan and Prince Edward Island. An estimated 32.4 gigawatt hours (GWh) of electricity from ERES were delivered to the grid in Saskatchewan as well as 13 GWh in Prince Edward Island. These projects resulted in an estimated emissions reduction of 29 000 tonnes of GHGs in Saskatchewan and 11 000 tonnes in Prince Edward Island.
- NRCan also continued to receive 10 000 GWh of electricity from ENMAX Corporation in Alberta. This purchase resulted in GHG emissions reductions of about 9000 tonnes annually.
- Energy Ottawa was the successful bidder for a Request for Proposals in Ontario for the purchase of 90 GWh of electricity from renewable resources, annually, for a period of five years. The Government of Canada has been receiving supply from Energy Ottawa since May 2004.

For more information:
nrcan.gc.ca/redi

Renewable Energy Programs: Photovoltaic and Hybrid Systems Program

Objective: To support the development and application of solar photovoltaic technologies and the integration of distributed energy resources to the electrical grid in Canada.

The program contributes to increasing the use of photovoltaic energy technologies in Canada by developing technologies and by facilitating the development of a Canadian-based globally competitive solar industry. It also contributes to the development of policies and programs.

In collaboration with Canadian industry and universities as well as international energy research organizations, the program undertakes research and development activities and fosters information exchanges that will encourage the adoption of photovoltaic-hybrid systems that produce electricity from solar energy and another energy source; conducts research to address the impact of decentralized energy on the electricity distribution network; validates the performance and safety of utility-interactive inverter products; supports the development of building-integrated photovoltaic technologies and systems; and facilitates the development and adoption of harmonized standards and codes for photovoltaic and distributed generation systems in Canada.

Key 2004–2005 Achievements

- Partnered with the Royal Architectural Institute of Canada and the University of British Columbia to develop and deliver a series of professional development courses for technology and sustainable environmental design, focusing on the application of *Building Integrated Photovoltaic Technology* with 175 participants in six Canadian cities.
- Championed a national initiative to address the issue of two-way electricity metering and net-metering in collaboration with Measurement Canada and the Electro-Federation of Canada.
- Collaborated with utilities and research community to develop network benchmarks and completed studies to address the impact of decentralized energy resources when connecting and supplying electricity to the Canadian electricity distribution network.

For more information:
cetc-varennes.nrcan.gc.ca/en/er_re.html

Renewable Energy Programs: Bioenergy Technology Program

Objective: To support efforts by Canadian industry to develop bioenergy technologies.

Technologies supported by this program include combustion, biochemical conversion of biomass to ethanol, thermochemical conversion of biomass to bio-oil and biogas, and biomass preparation and handling. Activities are directed toward improving the reliability and lowering the cost of technologies, disseminating information on technology feasibility and economics to potential users, and helping industry commercialize its products in domestic and foreign markets.

Key 2004–2005 Achievements

- With ongoing support from NRCan and other federal departments, Iogen Corporation is continuing on a successful path to full-scale commercialization of its process for producing fuel ethanol from agricultural residues, such as straw. Iogen's demonstration plant in Ottawa, Ontario, began producing ethanol from wheat straw in April 2004. The plant is the first of its scale in the world – designed to produce 3 to 4 million litres of ethanol per year.
- NRCan supported the University of Toronto in the development of an innovative technology that can convert seed oils, waste grease, animal fats and tallow into high-quality biodiesel fuel. The technology uses mild reactor conditions to yield a superior biodiesel with significant reductions in capital and operational cost. BIOX Corporation of Oakville, Ontario, licensed the process and successfully operated a one-million-litres-per-year pilot demonstration plant. BIOX has received support from Sustainable Development Technology Canada (SDTC) to build a 60-million-litres-per-year commercial demonstration plant.
- Through NRCan R&D support, Canadian biomass companies such as Ensyn, Enercam Dynamotive and Nexterra are advancing technologies toward commercialization. As a result of this support, many of those companies have moved toward the next level of commercialization and are now receiving funding from SDTC, the Federation of Canadian Municipalities, Technology Partnerships Canada and provincial and territorial agencies.

For more information:
canren.gc.ca/bio/index.asp

Renewable Energy Programs: Renewable Energy Deployment Initiative (REDI)

Objective: To stimulate the demand for renewable energy systems by helping the supply industry in its marketing and infrastructure development efforts, including the provision of financial incentives.

REDI targets four systems: solar water heating, solar air heating, earth energy, and high-efficiency, low-emissions biomass combustion. REDI promotes these systems in the business, federal and industrial markets through three means: a financial incentive, market assessment, and information and awareness.

Key 2004–2005 Achievements

- REDI leveraged taxpayers' funds at the rate of 6:1 by distributing $3.2 million in REDI financial incentives among 95 projects valued at $21 million; the projects were completed in 2004–2005.
- REDI promoted innovation by supporting the commercialization of two new solar technologies: a glazed solar air-heating technology from Newfoundland and Labrador and a solar concentrator developed in Ottawa that combines solar heat and photovoltaic power and sets a new benchmark for efficiency of solar collectors. REDI also paid for testing of these new systems at the National Solar Test Facility and the National Research Council's Canadian Centre for Housing Technology.
- In collaboration with the solar industry and the Canadian Standards Association, REDI developed a new standard for solar water-heating systems.

For more information:
nrcan.gc.ca/redi

TABLE 7-3

REDI for Business Projects Completed, 1998–1999 to 2004–2005

	Number of projects completed	*Estimated GHG reduction (tonnes CO_2/yr.)*	*Client investment*	*Federal incentive*
1998–1999	8	2869.0	$1,306,295	$145,950
1999–2000	9	260.8	$479,633	$119,910
2000–2001	24	5825.4	$1,849,918	$327,078
2001–2002	43	21.7	$5,827,561	$1,197,965
2002–2003	33	5718.8	$2,745,834	$606,210
2003–2004	89	39 653.5	$22,356,375	$2,551,845
2004–2005	95	22 413.7	$21,350,084	$3,200,000
Total	**301**	**76 762.9**	**$55,915,700**	**$8,148,958**

Renewable Energy Programs: Renewable Energy Technologies (RET) Program

Objective: To promote energy diversity and support efforts by Canadian industry to develop renewable energy technologies.

The Renewable Energy Technologies (RET) program aims to improve the economics and efficiency of renewable energy technologies, including small hydro (less than 20 megawatts), thermal solar and wind energy. It is actively involved in research and development to support the growth of the renewable energy industry in Canada. This growth will be achieved through: identifying and accelerating strategic research and development, development and deployment activities; fostering the commercialization of new technologies; identifying and developing opportunities for renewables integration; developing infrastructure to support innovation such as codes, policies and standards; developing linkages between utilities, industry and academia; resource assessment; supporting training and education; dissemination of results and findings; support of policy and programs; and international collaboration through the International Energy Agency (IEA).

Key 2004–2005 Achievements

- Launched the Drake Landing Solar Community on March 30, 2005. This seasonal solar thermal storage project, conceived and led by RET, is a 52-home subdivision in Alberta that will capture solar energy in the summer and store it for use in the winter. The solar district heating system will meet 90 percent of the community's residential space heating needs, a result unprecedented anywhere in the world.
- Played a key role in refurbishing the 100-year-old small hydro generating station at Chaudière Falls on the Ottawa River, in partnership with Energy Ottawa. Energy Ottawa has won a contract to supply $9 million worth of "green power" to the federal government from hydroelectric generating stations – the largest agreement of its kind in Ontario.
- Supported Yukon Energy Corporation and Vuntut Development Corporation, an Aboriginal organization, in carrying out a wind and icing monitoring project on Crow Mountain near the community of Old Crow, Yukon, north of the Arctic Circle. The results of this project will help reduce the climatic barriers to using wind energy in the North and develop expertise in wind resource assessment in severe conditions.

For more information:
canren.gc.ca

Renewable Energy Programs: Wind Power Production Incentive (WPPI)

Objective: The WPPI is a 15-year, $260-million program to support the installation of 1000 megawatts of new wind energy capacity or the production of 2.6 terrawatt-hours by March 31, 2007.

The WPPI encourages electric utilities, independent power producers and other stakeholders to gain experience in wind power, an emerging energy source. The incentive is approximately $0.01per kilowatt hour of production and represents about half of the current cost of the premium charged for wind energy in Canada for facilities where good wind resources exist. Eligible recipients can receive the incentive for 10 years.

Key 2004–2005 Achievements

- Two new wind energy projects were commissioned in fiscal year 2004–2005. Both projects are located in Alberta. These projects contributed about 100 megawatts of new wind energy capacity. Since its introduction in 2002, more than 206 megawatts of new wind power has been commissioned under the WPPI program, representing 11 projects and a total financial commitment of $79 million.
- In the October 2004 Speech from the Throne, the Government of Canada made a commitment to quadruple the Wind Power Production Incentive program. In the 2005 Federal Budget, the Government of Canada announced that it would invest an additional $920 million over 15 years to increase the WPPI target to 4000 megawatts.

For more information:
canren.gc.ca

Renewable Energy Programs: Market Incentive Program (MIP)

Objective: The MIP is a $25-million program to stimulate emerging markets for renewable electricity. Funding is available until March 31, 2007.

Under the program, electric utilities, retailers and marketers submit proposals for consideration by NRCan and Environment Canada for projects to develop market-based programs and promote the sale of electricity from emerging renewable sources, having low environmental impact, to residential and small-business customers. The Government of Canada is to provide a short-term financial incentive of up to 40 percent of the eligible costs of an approved project, to a maximum contribution of $5 million per recipient.

The program's carbon dioxide reduction objectives are 1.4 megatonnes per year by 2010.

Key 2004–2005 Achievements

- Signed six contribution agreements for marketing initiatives in Alberta (2), Manitoba, Ontario (2) and Nunavut bringing the total number of agreements to nine.
- NRCan commissioned a broad study to formulate a program development strategy, given the success factors and barriers to green power marketing.
- Environment Canada commissioned a study to review and assess the implementation and effectiveness of customer rebate programs and determine whether a customer rebate program could improve the success of green power marketing in Canada.

For more information:
reed.nrcan.gc.ca

Renewable Energy Programs: ENergy from the FORest (ENFOR)

Objective: To improve the understanding of the role of biomass production for energy and to improve biomass productivity from natural forests and from plantations growing willow and poplar.

ENFOR, managed by the Canadian Forest Service (CFS) of NRCan, undertakes research and development (R&D) on the production and harvesting of forest biomass for energy through the private sector, universities or CFS research centres. ENFOR also investigates the broader environmental effects of harvesting from forests and short-rotation plantation culture, focusing on sustaining forest productivity and improving the sequestration and storage of atmospheric carbon in forest ecosystems. ENFOR also supports research on information systems to determine the quantity and quality of biomass in Canadian forests.

Key 2004–2005 Achievements

- Major successes include additional refinement of the Forest Biomass Inventory of Canada; the modelling of whole-tree harvesting/nutrient cycling; the Carbon Budget Model of the Canadian Forest Sector; and the development and testing of species, clones and the establishment and fertilization of energy plantations.
- The IEA publication titled "Benefits of Bioenergy" provides an overview of the wide range of biomass sources and conversion technologies available. It also provides case studies from the Member Countries of practical bioenergy solutions. These are highlighted because they satisfy both energy demands and wider sustainable development outcomes. The brochure is available on the IEA Bioenergy Web site at www.ieabioenergy.com/media.php.
- Several species/varieties of willow and poplar have been assessed and are being tested for production in Ontario, Quebec and the Prairie provinces. Plantation establishment has been successful in many regions and growth and yield data is being gathered. Industry in western Canada is now engaged in the large-scale planting of fast-growing poplars.

For more information:
nrcan.gc.ca/cfs-scf/science/resrch/bioenergy

Chapter 8: Federal House in Order

Introduction

The Government of Canada is the country's largest single enterprise. It is working to get its house in order by setting a target of a 31 percent reduction in greenhouse gas (GHG) emissions from its own operations by 2010.

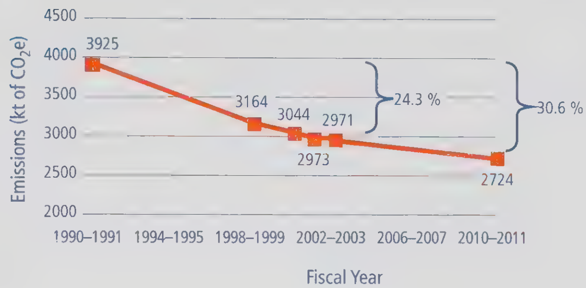
Since 1990, through building retrofits, better fleet management, strategic "green power" purchases and the downsizing of operations, the Government of Canada has already achieved a 24 percent emissions reduction. The Government of Canada will reduce its net emissions by a further 12 percent by 2010.

The Government of Canada will achieve its goal by additional building retrofits, fuel switching, improved fleet management, energy-efficient procurement and increased use of renewable energy within government operations. Moreover, the Government of Canada can help to "create the market" for certain new technologies on the verge of becoming viable. Key departments, which are responsible for 95 percent of government GHG emissions, have been assigned specific targets and must report annually on their progress.

The task of target sharing entails assigning specific targets to the 11 largest emitting departments based on the emission-reduction opportunities identified within each organization. Natural Resources Canada (NRCan) is taking a lead role in managing this task and in providing programs and support to departments and agencies that will help them achieve their targets. A leadership component of the Federal House in Order initiative encourages the reduction of all federal emissions by engaging the active participation of the departments, agencies and Crown corporations that were not designated with a target.

FIGURE 8-1

GHG Emissions Reductions From Federal Operations, 1990 to 2010



Federal Buildings Initiative (FBI)

Objective: To assist Government of Canada organizations to implement energy efficiency improvements, leading to reduced energy use, GHG emissions and operating costs.

The Federal Buildings Initiative (FBI) facilitates comprehensive energy efficiency upgrades and building retrofits for departments, agencies and Crown corporations of the Government of Canada. The FBI provides advice and consultation on project opportunities, model performance contracting documents, celebration and recognition opportunities, and a national network for energy management training. In facilitating public-private partnerships, the FBI manages a qualified list of energy management firms that provide a turnkey service to federal organizations, including project engineering and construction, third-party private sector financing, project monitoring, and employee training and awareness. FBI program officers work with federal organizations from project inception through to contract award and project monitoring and verification.

Key 2004–2005 Achievements

- The Royal Canadian Mint signed its first FBI contract for a project at its Sussex Drive location in Ottawa. The $8-million investment will result in guaranteed energy and water savings of $787,000 annually.
- New and incremental investment by the private sector in FBI projects of $12.8 million.
- Project opportunities were developed with first-time federal clients, including the Canadian Museum of Nature, the Canada Mortgage and Housing Corporation, and Fisheries and Oceans Canada.

For more information:
oee.nrcan.gc.ca/fbi/home_page.cfm

Energy Technology Applications Group

Objective: To provide technical and project management services to assist federal facilities to implement energy-reduction projects.

The Energy Technology Applications Group's (ETAG's) extensive experience in building energy systems and access to the engineering and scientific network within the CANMET Energy Technology Centre (CETC) ensures that environmentally responsible technologies are considered when federal government clients replace or modify their energy systems. ETAG changed its name from the Federal Industrial Boiler Program (FIBP) in 2004 to better reflect the range of energy technologies that it deals with and its role as technical support and liaison between federal facilities and the energy technology groups within CETC. Since its inception in 1991, the ETAG (then FIBP) has worked with such departments as Agriculture and Agri-Food Canada, Correctional Service Canada (CSC), Environment Canada, the Department of Foreign Affairs and International Trade (now divided into Foreign Affairs Canada and International Trade Canada) and National Defence to reduce their energy costs. Through projects implemented by ETAG, GHG emissions are reduced by an average of 4.7 kilotonnes per year.

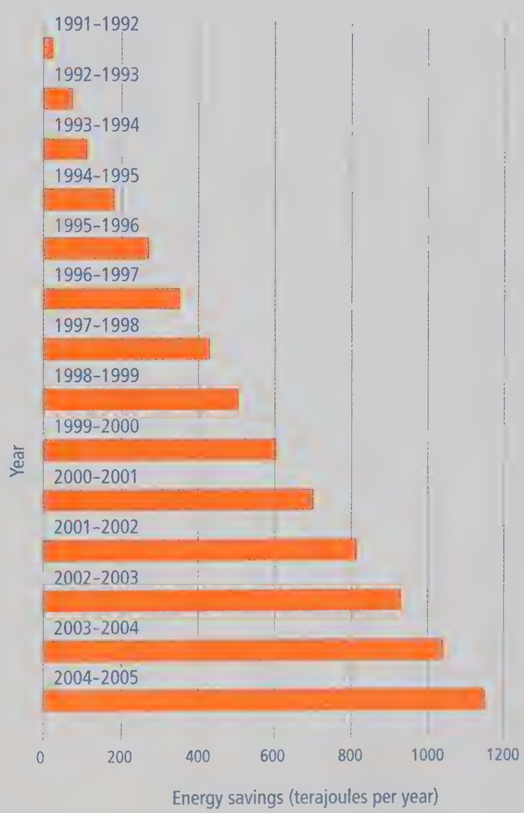
Key 2004–2005 Achievements

- Worked with CSC to continue its Federal House in Order-sponsored wind power projects. ETAG managed the installation of three wind monitoring towers at CSC's most promising sites – Dorchester, New Brunswick; Port Cartier, Quebec; and Drumheller, Alberta. Analysis of the wind data and the site electrical profile indicates 250-kilowatt wind turbines are appropriate. Funding is in place for two sites. ETAG will be proceeding with detailed project engineering. Once implemented, the wind turbines will reduce annual carbon dioxide emissions by 450 000 kilograms.
- Worked with CSC sites in the area of Kingston, Ontario, to review heating plant operations and develop options to reduce energy use, operating costs and environmental emissions. After conducting a feasability study for Joyceville Institution, ETAG developed the technical requirements for a new boiler and control system upgrade that will be implemented in 2005. The project will cost $450,000.
- Conducted efficiency and emission testing at Canadian Forces Base Greenwood's new heating plant to determine performance of low-nitrogen-oxide burner technology. The performance data was presented in discussions with Environment Canada regarding updating nitrogen oxide emission guidelines from federal government operations when burning heavy fuel oil.

For more information:
etag-gate.ca

FIGURE 8-2

Annual Energy Savings From the ETAG, 1991–1992 to 2004–2005



Federal Vehicles Initiative

Objective: To assist federal government departments to increase the energy efficiency of their motor vehicle fleets and reduce the environmental impact of federal vehicle operations and to promote the *Alternative Fuels Act* within the federal fleet.

The Federal Vehicles Initiative provides fleet managers with an assessment of fleets as well as technical advice and encouragement on acquiring and using alternative transportation fuels. Four departments participate in planning and reporting on the initiative: Environment Canada, NRCan, Public Works and Government Services Canada, and Treasury Board of Canada Secretariat. NRCan is responsible for implementing the program.

Key 2004–2005 Achievements

- Established two new E85 bulk fuel sites.
- Trained 1445 federal vehicle operators at workshops; trained an additional 205 operators on-line.
- Assisted in purchasing 682 Leadership Vehicles (497 alternative fuel vehicles and 185 hybrid vehicles).

For more information:
oee.nrcan.gc.ca/communities-government/transporation/federal/mandate.cfm

FIGURE 8-3

Federal Fleet Size and Fuel Consumption, 1995–1996 to 2003–2004

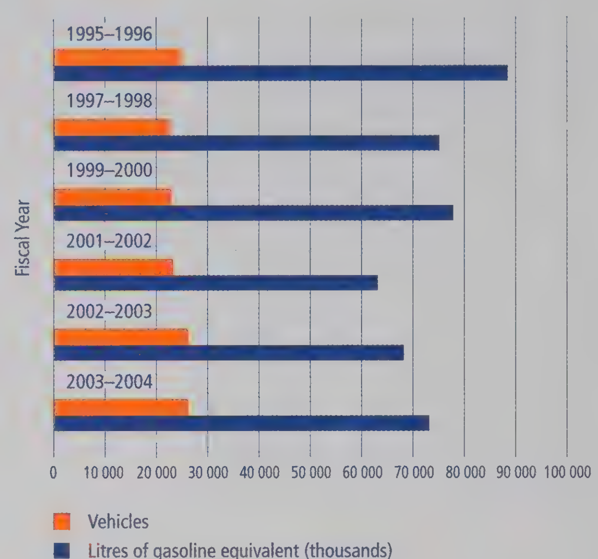
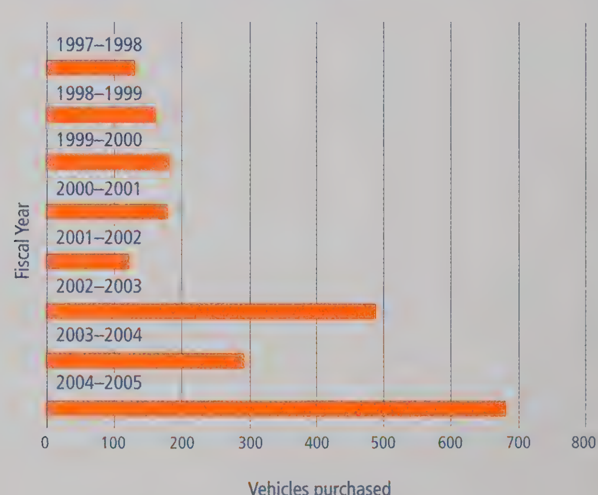


FIGURE 8-4

Purchases of Alternative Fuel Vehicles (Including Hybrids) for the Federal Fleet, 1997–1998 to 2004–2005



Chapter 9: General Programs

Outreach

Objective: To increase Canadians' awareness and understanding of climate change and the link to energy use, and to encourage Canadians to take action.

The Outreach program provides information and activities to encourage Canadians to integrate energy efficiency into their energy-use decisions. Outreach supplements program communications activities with publications, exhibits, joint projects and the Office of Energy Efficiency Web site.

The Outreach program targets youth as future energy consumers by investing in joint initiatives in the education sector and through promotional projects. Public information activities increase awareness of the environmental impact of energy use. They also encourage consumers to adopt energy-efficient practices and to switch to alternative forms of energy.

As a component of the Outreach program, the One-Tonne Challenge was launched in March 2004. The One-Tonne Challenge is co-managed with Environment Canada, with input from and coordination with other departments, such as Transport Canada. The One-Tonne Challenge asks Canadians to reduce greenhouse gas (GHG) emissions by one tonne. Canadians are challenged to use less energy, to reduce waste and to conserve water and other resources. Reduced emissions will protect the climate and result in cleaner air and healthier communities for all Canadians.

Key 2004–2005 Achievements

- Interest and demand for energy efficiency information has continued to increase – 53 percent increase in the volume of publications distributed (now at 5.6 million) and 30 percent increase in visits to the Web site (2 million).
- The One-Tonne Challenge was introduced to the Canadian public and potential partners, including a successful advertising campaign noted by over 50 percent of Canadians. Activity levels in the first year of the program are high with over 1.7 million Web site visits, 55 000 on-line pledges, distribution of 900 000 One-Tonne Challenge guides and more than 20 partners actively involved in the program.

For more information:
oee.nrcan.gc.ca/corporate/programs.cfm#Outreach

RETScreen® International Clean Energy Decision Support Centre

Objective: To build the capacity of planners, decision-makers and industry to implement renewable energy and energy efficiency projects.

This objective is achieved by developing decision-making tools that reduce the cost of pre-feasibility studies, by disseminating knowledge to help people make better decisions, and by training people to better analyse the technical and financial viability of possible projects.

Key 2004–2005 Achievements

- Increased the number of users of the RETScreen International Clean Energy Project Analysis Software to more than 56 000 people in 206 countries, with the number of people benefiting from this decision-support and capacity-building tool now growing at more than 300 new users every week.
- Released a number of new or improved RETScreen tools, including a new Combined Heat and Power (CHP) Software Model, a Chinese version of the Photovoltaic Project Software Model, and a new on-line e-learning course.
- Published the results from an independent RETScreen impact assessment that determined that RETScreen International has had a significant impact in the short time that the software and related tools have been available, including saving stakeholders an estimated $240 million in Canada and $600 million worldwide through the use of the RETScreen software and related tools.

For more information:
retscreen.net

Program of Energy Research and Development (PERD)

Objective: To fund research and development (R&D) designed to ensure a sustainable energy future for Canada in the best interests of our economy and our environment.

The PERD budget for 2004–2005 was approximately $58 million. Natural Resources Canada (NRCan) allocated $41 million to energy R&D programs managed and performed in the department, approximately 50 percent of which contributed to improved energy efficiency in Canada.

Examples of funded projects are included in the performance reporting in Chapters 3 to 7 of this report. The remaining $17 million was allocated to 10 federal departments that are partners in the PERD.

For more information:
www2.nrcan.gc.ca/es/oerd/english/View.asp?x=665

Climate Change Technology Development and Innovation Program (of the *Government of Canada Action Plan 2000 on Climate Change*)

Objective: To accelerate the development of cost-effective R&D mitigation technologies in multiple sectors, building the intellectual foundation for long-term technological advances, building alliances and partnerships and demonstrating federal leadership towards sustainable development.

The Climate Change Technology Development and Innovation Program received $20 million over six years (2001–2006) as a part of the *Government of Canada Action Plan 2000 on Climate Change*.

Key 2004–2005 Achievements

- Conducted a pilot demonstration project regarding the sequestration of carbon dioxide in oil sands tailings, a technology that may reduce greenhouse gases and could also be used in the disposal process of tailings.
- Tested digester and cogeneration systems and processes for more efficient hog manure management.
- Published research papers documenting the physical, thermal and geochemical characteristics of gas-hydrate-bearing sediments. Gas hydrates are a naturally occurring "ice-like" combination of natural gas and water that could provide an immense resource of natural gas from the world's oceans and polar regions.

International Initiative for Technology Development Program

Objective: To identify and develop technology transfer projects and facilitate the expansion of market opportunities for climate change technologies.

The International Initiative for Technology Development Program received $10 million over six years (2001–2006) as part of the *Government of Canada Action Plan 2000 on Climate Change*.

Key 2004–2005 Achievements

- Provided technology and project listings to the Web-based information clearing house of the United Nations Framework Convention on Climate Change.
- Completed four Requests for Proposals that provided funding for 20 feasibility studies.

Climate Change Technology and Innovation Research and Development (T&I R&D)

Objective: To contribute to the *Climate Change Plan for Canada*'s objective to "advance promising GHG technologies through R&D, demonstration and early adoption initiatives to achieve long-term GHG reductions and strengthen Canada's technology capacity."

Implemented in 2003 with $115 million over five years of federal funding, T&I R&D is based on long-term strategic planning that takes into account expected energy futures and visions to the year 2025. R&D is conducted in the five strategic areas of cleaner fossil fuels, advanced end-use efficiency technologies in buildings, transportation and industry, decentralized energy production (including renewables), biotechnology and the hydrogen economy.

The T&I R&D budget for 2004–2005 was $10 million. NRCan allocated $8 million to energy R&D programs managed and performed in the department. Key NRCan R&D achievements that contributed to improved energy efficiency in Canada are included in the performance reporting in Chapters 3 to 7 of this report. The remaining $2 million was allocated to six federal departments that are partners in T&I R&D.

Chapter 10: Cooperation

Introduction

This chapter describes Natural Resources Canada's (NRCan's) cooperation with respect to efficiency and alternative energy (EAE) during the reporting period at the provincial/territorial and international levels. Examples of program cooperation are set out in previous chapters in the Key Achievements sections of specific EAE program initiatives. It also should be noted that municipal governments and agencies participate in NRCan's EAE measures as clients (e.g. for training workshops; as recipients of financial incentives) and partners (e.g. in anti-idling projects). NRCan also participates in ventures led by municipal organizations (e.g. Green Municipal Fund, as explained in the accompanying textbox) and provincially/territorially regulated electricity and provincially regulated natural gas utilities.

Green Municipal Fund

- The Green Municipal Funds were created in Budget 2000 by an endowment of $125 million to the Federation of Canadian Municipalities (FCM) to support municipal government action to reduce greenhouse gases, cut pollution and improve the quality of life. The funds were doubled in Budget 2001 for a total of $250 million – $50 million for the Green Municipal Enabling Fund and $200 million for the Green Municipal Investment Fund.
- The Government of Canada signed an Agreement with the FCM, a non-profit organization, to deliver the Green Municipal Fund. Under the agreement, the Government of Canada (NRCan and Environment Canada) shares in the governance of the Green Municipal Fund, along with representatives from the public and private sectors, including municipal officials and technical experts, through participation on a Peer Review Committee and a governing Council. The FCM Board of Directors approves projects based on Council's recommendations.

Federal-Provincial and Federal-Territorial Cooperation

Provincial and territorial governments assisted the delivery of a substantial number of EAE programs during the reporting period to reduce energy costs, increase competitiveness, improve air quality and generate economic and trade opportunities. Coordination between the federal and provincial/territorial levels is essential to avoid duplication and ensure efficient program delivery. During the reporting period, the governments cooperated at the general level and at the level of specific program initiatives.

Cooperation Agreements

NRCan's Letter of Cooperation (LOC) on EAE with the Agence de l'efficacité énergétique du Québec during the reporting period ensures an efficient consultation and exchange of information between the two governments, and helps the coordination of EAE activities in the province and the creation of opportunities for joint projects. The management committee established under the LOC met during the year to review policy and program developments, progress on joint program initiatives and areas for further cooperation. The LOC played a considerable role in facilitating the conduct of three activities in particular:

- management of the licensing agreement for delivery of EnerGuide for Houses.
- the processing of projects submitted to the Energy Innovators Initiative and the Commercial Building Incentive Program by public organizations in Quebec; this cooperation framework is also being applied to other NRCan programs aimed at the public sector in Quebec.
- management of an agreement relating to the Programme d'intervention en réfrigération dans les arenas du Québec, under which NRCan has provided technical support for the implementation of innovative refrigeration systems in Quebec's ice rinks.

NRCan's LOC on energy efficiency and renewable energy with the Government of Yukon facilitates information exchange and the creation of opportunities for joint projects in Yukon, including partnering with the Yukon Development Corporation to create the Canada-Yukon Energy Solutions Centre in Whitehorse. The Centre provides access to relevant technical services and programs for the Yukon population and undertakes outreach and public education activities.

The Government of Canada contributes to the Arctic Energy Alliance to promote energy efficiency and renewable energy in the Northwest Territories and to facilitate opportunities for EAE projects. The Alliance also is the delivery agent in the Northwest Territories for the EnerGuide for Houses initiative.

The Government of Canada promotes energy efficiency and renewable energy in Alberta by working with Climate Change Central, a not-for-profit corporation which is funded by a multi-stakeholder base, including the Government of Alberta.

National Advisory Council on Energy Efficiency (NACEE)

NRCan created NACEE in April 1998 to advise and guide the Office of Energy Efficiency (OEE) on the most effective way to achieve its mission. Its membership is drawn from across Canada and all economic sectors, including provincial/territorial officials and representatives of electricity and natural gas utilities, who have the opportunity to comment on the OEE's business plan and programs. NACEE met three times during 2004–2005.

International Cooperation

NRCan cooperates with several international organizations and foreign governments in EAE program areas. Canada benefits from this cooperation:

- by learning about improved ways of designing and delivering EAE programs to meet policy objectives
- through the harmonization of energy efficiency tests and performance standards that helps reduce barriers to trade in energy-using products

International Energy Agency (IEA)

The IEA, based in Paris, France, is an autonomous agency within the framework of the Organization for Economic Co-operation and Development. The IEA carries out a comprehensive program of energy co-operation among its 26 member countries, including Canada. IEA member governments have committed to sharing energy information, coordinating energy policies and cooperating in the development of rational energy programs. The IEA and its Governing Board are assisted in their work by several standing groups and special committees, which bring together energy specialists from member countries.

The Standing Group on Long-Term Cooperation (SLT) is the key committee on the policy side. It analyses policies to promote conservation and the efficient use of energy, the increased use of alternatives to oil and other measures to increase long-term energy security while protecting the environment. The SLT monitors energy developments in member countries and makes recommendations on energy policy through a regular series of individual country reviews. The Energy Efficiency Working Party (EEWP) of the SLT undertakes IEA work on specific issues related to energy efficiency. Canada is represented at the EEWP by NRCan's OEE.

Canada's international energy research and development objectives are mainly advanced through the IEA's Working Parties, implementing agreements and the Committee for Energy Research and Technology (CERT), chaired by NRCan. Canada participates in 31 of the IEA's 40 implementing agreements, i.e. R&D collaboration programs.

NRCan is a member of the Centre for Analysis and Dissemination of Demonstrated Energy Technologies (CADDET), established under the IEA Agreement on Energy and Environmental Technologies Information Centres. CADDET is an international information network that helps managers, engineers, architects and researchers find out about energy-using technologies that have worked in other countries.

Canada also collaborates with research centres in member countries on several agreements and programs oriented toward research and development (R&D) and technology. NRCan facilitates R&D and commercial business ventures abroad by Canadian firms by undertaking a wide variety of activities, including participating in various IEA tasks and supporting technical and trade-oriented workshops and conferences.

United Nations

RETScreen® International is managed under the leadership of NRCan's CANMET Energy Technology Centre – Varennes (CETC–Varennes) through cost- and task-shared collaborations with other governments and multilateral organizations, and with technical support from experts in industry, government and academia. Key partners are the United Nations Environment Programme's Energy Unit of the Division of Technology, Industry and Economics; Global Environment Facility-sponsored Sustainable Alternatives Network; Risoe Centre on Energy, Climate and Sustainable Development; and the Solar and Wind Energy Resource Assessment project. Other international partners include the World Bank's Prototype Carbon Fund; the National Aeronautics and Space Administration's Langley Research Center; the Barbados Ministry of Energy and Public Utilities; the United States Agency for International Development; and the Korean Institute for Energy Research.

China

In February 2001, Canada and China signed a Memorandum of Understanding (MOU) on Energy Cooperation. In January 2003, they signed an MOU on climate change and the Clean Development Mechanism. Energy efficiency is among the areas of cooperation identified in both MOUs.

Mexico

NRCan signed a MOU on EAE cooperation with the Mexican Energy Secretariat in June 1996. Its objective is to contribute to the EAE objectives of Canada and Mexico by improving the design and delivery of EAE programs and enhancing trade, investment and exchanges (technical and other) related to energy-efficient products, energy management services and alternative energy goods and services.

In 2004–2005, NRCan, in cooperation with CONAE (The Mexican National Commission for Energy Savings) organized an energy efficiency workshop in Saltillo, Mexico, under the MOU. NRCan officials participated in the workshop.

United States

NRCan and the U.S. Department of Energy (DOE) have an MOU on road transportation, energy efficiency and alternative fuels. It provides a formal mechanism for negotiating and harmonizing North American policy on fuel efficiency, fuel quality and alternative transportation fuels. The MOU provides a framework for joint projects and studies in areas of mutual interest, such as the costs and market potential of hybrid electric-powered and diesel-powered vehicles. The MOU facilitates bilateral discussion of a broad range of issues in the motor vehicle and fuels policy area and affords access to technology assessments and policy-related studies conducted for the DOE by its national laboratories.

Canada also cooperates with the U.S. DOE on energy R&D in the areas of fuel cells, fossil fuels, bioenergy, community systems and microgeneration, nuclear fission, and carbon sequestration. Discussions took place in 2004 to replace a Memorandum of Understanding, the original mechanism for Canada-U.S. energy R&D collaboration, with a Bilateral Collaboration Treaty in Energy Research and Development.

United States and Mexico

NRCan continues to participate with the United States and Mexico in the North American Energy Working Group's (NAEWG's) Energy Efficiency Experts Group to promote the harmonization of energy efficiency test methods, mutual recognition of conformity assessment systems for energy efficiency standards and cooperation on trilateral energy efficiency labelling programs. During the review period, work was initiated to compare test standards for central air conditioners and transformers and other products. Mexico continued to review implementation of ENERGY STAR® and adoption of a new approach, developed in Canada and the U.S., for promoting the replacement of inefficient electric motors. A trilateral stakeholder meeting was held in conjunction with the annual meeting of the Council for the Harmonization of Electrotechnical Standards for the Nations of the Americas, which provided feedback on ways for more effective interaction between the group and the NAEWG.

Also under the umbrella of the NAEWG, Canada, the United States and Mexico have been charged with implementing an initiative that will contribute to accelerating the adoption of affordable and appropriate sustainable housing solutions for rapidly growing regions of Mexico. In early 2004, the CANMET Energy Technology Centre (CETC) of NRCan was nominated as the lead of the NAEWG Science and Technology Experts Group for a sustainable housing project in Mexico known as La Casa Nueva/La Comunidad Nueva (LCN).

In October 2004, Prime Minister Paul Martin and President Vincente Fox established the Canada-Mexico Partnership (CMP). The CMP is designed to be a high-level public-private sector alliance that would serve as a mechanism for identifying policies for facilitating cooperation, enhancing investment and creating opportunities for Canadian entrepreneurs to take part in projects that contribute to the socio-economic development of Mexican society.

Three themes were identified as priorities under the CMP. These are

- Housing and Urban Development
- Competitiveness
- Human Capital

The Housing and Urban Development theme is being led by two agencies, Canada Mortgage and Housing Corporation (CMHC) for issues related to housing, and Industry Canada's Sustainable Cities Initiative for issues related to urban development. Within the housing technology theme, a number of activities related to housing technology, energy efficiency, renewable energy and sustainable communities were identified as areas of interest by Mexico. As a result of previous and ongoing technology cooperation activities by CETC in Mexico through the NAEWG-LCN initiative, CMHC invited CETC to help develop the Terms of Reference for the housing technology activities under the CMP and further requested the involvement and technical input of CETC in furthering specific activities under the housing technology working group under the CMP.

In parallel, Industry Canada's Sustainable Cities Initiative is undertaking a number of targeted projects in the cities of Matamoros and Reynosa, Mexico, to foster sustainable solutions to many of the energy and environmental pressures facing most Mexican cities. These activities are being brought under the umbrella of the CMP. Sustainable and energy-efficient housing is one of the priority areas identified under the Sustainable Cities Initiative. CETC has been invited to assist and manage the implementation of the sustainable housing elements of the Sustainable Cities Initiative, leveraging and providing a bridge between the housing technology working group under the CMP and the NAEWG-LCN activities.

Appendix 1: NRCan's Efficiency and Alternative Energy Initiatives and Expenditures, 2004–2005

(millions of dollars)

Energy Efficiency – Equipment **$9.2**

Energy Efficiency Standards and Regulations
Equipment Labelling and Promotion
EnerGuide for Industry
Mine Ventilation

Energy Efficiency – Housing and Buildings **$76.8**

R-2000 Standard and EnerGuide for (New) Houses
Super E™ House Program
EnerGuide for Houses and Retrofit Incentives
Housing Energy Technology Program
Commercial Building Incentive Program
Industrial Building Incentive Program
Green Buildings Program
Federal Buildings Initiative
Energy Technology Applications Group
Energy Innovators Initiative
Refrigeration Action Program for Buildings
Buildings Program – Intelligent Buildings
Building Energy Simulation Program
Community Energy Systems Program

Energy Efficiency – Industry **$30.1**

Industrial Energy Efficiency (Canadian Industry Program for Energy Conservation; Industrial Energy Innovators)
Cleaner Fossil Fuel Power Generation
Processing and Environmental Catalysis Program
Industrial System Optimization Program
Industry Energy Research and Development Program
Emerging Technologies Program
Industrial Energy Innovation
Minerals and Metals Program

(millions of dollars)

Energy Efficiency – Transportation **$16.1**

Vehicle Efficiency
EnerGuide For Vehicles
Personal Vehicles
Fleet Vehicles
Federal Vehicles Initiative
Canadian Lightweight Materials Research Initiative

Alternative Energy – Transportation **$54.2**

Fuel-Cell-Powered Mining Vehicles
Future Fuels Initiative
Ethanol Expansion Program
Biodiesel Initiative
Canadian Transportation Fuel Cell Alliance
Hydrogen Fuel Cells and Transportation Energy Program

Alternative Energy – Renewable Energy Sources **$21.9**

Initiative to Purchase Electricity From Emerging Renewable Energy Sources
Photovoltaic and Hybrid Systems Program
Bioenergy Technology Program
Renewable Energy Deployment Initiative
Renewable Energy Technologies Program
Wind Power Production Incentive
Market Incentive Program
ENergy from the FORest (ENFOR)

General Programs[1] **$26.8**

Outreach
RETScreen® International Clean Energy Decision Support Centre
National Energy Use Database

Total **$235.1**

[1] Totals allocated for funding programs in Chapter 9 are reflected in the relevant program entries.

Appendix 2: Data Presented in Report

The aggregate energy use data presented in this report are taken from Statistics Canada's *Report on Energy Supply–Demand in Canada* (RESD). Differences exist between this report and *Canada's Emissions Outlook: An Update* (CEO Update) concerning the sector allocations of RESD energy use data. The CEO Update's sector allocation is based on Environment Canada's *Trends in Canada's Greenhouse Gas Emissions 1990–1997*, whereas this report uses a definition better suited for the purpose of energy end-use analysis. Some modifications to the original Statistics Canada data were required and are documented in Appendix B of NRCan's *Energy Use Data Handbook, 1990 and 1997 to 2003*.

FIGURE 1-1: Canada: Changes in Energy Intensity and the Energy Efficiency Effect, 1990 to 2003

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Intensity Index	1.00	1.00	1.00	1.00	0.99	0.98	1.00	0.96	0.91	0.89	0.87	0.84	0.84	0.85
Index of Energy Efficiency Effect	1.00	0.98	0.97	0.94	0.94	0.92	0.93	0.91	0.89	0.88	0.87	0.87	0.87	0.87

FIGURE 1-2: Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Estimated energy use without energy efficiency improvements	1.00	1.00	1.03	1.07	1.12	1.15	1.18	1.20	1.20	1.25	1.29	1.27	1.31	1.34
Actual energy use	1.00	0.98	1.00	1.01	1.05	1.07	1.11	1.11	1.09	1.12	1.17	1.14	1.18	1.22

FIGURE 1-3: Electricity Production From Renewable Sources (GWh), 1991 to 2001

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
GWh	3649	4134	4477	5362	5422	5855	6419	6599	7372	7418	7512

FIGURE 2-1: Monthly Import Volumes

	Apr 04	May 04	Jun 04	Jul 04	Aug 04	Sep 04	Oct 04	Nov 04	Dec 04	Jan 05	Feb 05	Mar 05	**Total**
Paper	9193	7456	8046	6035	6236	6751	7080	5537	4967	5215	3531	4866	**74 913**
Electronic	24 929	26 792	28 730	30 563	30 279	29 339	31 518	29 647	29 294	29 519	30 266	34 672	**355 548**

FIGURE 2-7: Awareness Levels of ENERGY STAR in Canada

	Nov 01	Jan 03	Sep 03	Nov 04
Aware – Aided	26	32	40	44
Aware – Non-aided	13	17	25	29

FIGURE 2-8: ENERGY STAR Qualified Appliances as a Percent of Total Category Sales in Canada in 2003

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Refrigerators	24.1	21.3	24.7	27.4	35.5	36.7	37.7	40.4	42.2	47.6	45.9	46.1
Clothes washers	25.6	20.6	23.2	21.4	23.6	23.0	22.5	21.9	24.4	26.1	29.9	25.0
Dishwashers	33.2	31.5	30.8	36.5	41.5	46.7	47.3	50.7	60.7	63.5	65.5	66.7

FIGURE 3-1: Canadian Households by Type of Dwelling, 2003

	Number of households	Percentage
Single detached	6 908 256	57
Apartments	3 777 289	31
Single attached	1 271 438	10
Mobile homes	257 148	2
Total	**12 214 130**	**100**

FIGURE 3-2: Residential Energy Use by Purpose, 2003

	Energy Use (PJ)	Percentage
Space heating	873.4	60
Water heating	311.8	21
Appliances	189.0	13
Lighting	65.6	5
Space cooling	17.7	1
Total	**1457.6**	**100**

FIGURE 3-3: Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Estimated energy use without energy efficiency improvements	1.00	1.04	1.10	1.14	1.15	1.17	1.23	1.21	1.13	1.18	1.25	1.22	1.28	1.32
Actual energy use	1.00	0.98	1.01	1.04	1.07	1.05	1.13	1.08	0.99	1.03	1.08	1.04	1.08	1.13

FIGURE 3-4: Annual Heating Consumption for Houses Constructed to Different Standards

Description	EnerGuide for Houses Annual Heating Consumption (MJ)
Typical house built to R-2000 Standard	78 747
House built to *Model National Energy Code* (2002)	112 101
Typical new house (2002)	146 274
Typical existing house (1970)	216 812

FIGURE 3-5: Average Energy Consumption per Household, Pre-1946 to 2001–2004 Construction

Year Built	Average Energy Consumption (GJ)
Pre-1946	297
1946–1960	221
1961–1970	210
1971–1980	201
1981–1990	191
1991–2000	169
2001–2004	158
All EGH in Canada	220
R-2000	100

FIGURE 3-6: Average Energy Consumption of New Appliances*, 1990 and 2003 Models

	1990	2003
Clothes washers	1218	708.4
Clothes dryers	1103	914.2
Refrigerators	956	487.1
Dishwashers	1026	523.9
Ranges	772	709.4
Freezers	714	369.1

* kWh/yr.

FIGURE 3-7: Number of Eligible R-2000 Housing Starts, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Number of R-2000 Houses	495	699	1196	1299	784	610	416	484	265	213	319	329	428	379	582

FIGURE 3-8: National Trends in Air Leakage, Pre-1945 to 2000–2004 Construction

Year Built	First EGH Evaluation (A)	Post-Retrofit Evaluation (B)	R-2000
Pre-1945	11	8	n.a.
1945–1959	8	6	n.a.
1960–1969	6	5	n.a.
1970–1979	6	5	n.a.
1980–1989	5	5	0.9
1990–1999	5	4	1.1
2000–2004	4	3	1.1
Average	7	6	1.1

FIGURE 3-9: Evaluations Under EnerGuide for Houses, 1998–1999 to 2004–2005

Year of EGH Evaluation	1998–1999	1999–2000	2000–2001	2001–2002	2002–2003	2003–2004	2004–2005
Houses evaluated but not re-evaluated (A evaluation)	3675	9111	11 510	11 088	16 564	48 260	58 760
Houses retrofitted and re-evaluated (B evaluation)	832	226	607	709	1153	2724	18 081

FIGURE 3-10: Residential Energy Use and Energy Savings per Household*, Pre-1945 to 2000–2004

	Pre-1945	1945–1959	1960–1969	1970–1979	1980–1989	1990–1999	2000–2004	Average
Energy use pre-evaluation	299	229	222	213	206	190	182	231
Evaluation-identified energy savings	134	94	89	81	68	51	46	91
Actual energy savings after renovations	91	62	58	53	46	38	36	61

* Gigajoules

FIGURE 4-1: Commercial/Institutional Energy Use by Activity Type*, 2003

End Use	Energy Use	Percentage
Offices**	497.7	43
Retail Trade	157.4	13
Health Care and Social Assistance	135.2	12
Educational Services	117.8	10
Accommodation and Food Services	74.3	6
Wholesale Trade	58.8	5
Transportation and Warehousing	36.9	3
Information and Cultural Industries	35.0	3
Arts, Entertainment and Recreation	34.8	3
Other Services	24.0	2
Total	**1171.91**	**100**

* Excludes street lighting

** "Offices" includes activities related to finance and insurance; real estate, rental and leasing; professional, scientific and technical services; and public administration.

FIGURE 4-2: Commercial/Institutional Energy Use by Purpose*, 2003

End Use	Energy Use	Percentage
Space heating	644.05	55
Lighting	158.12	13
Auxilary motor	114.11	10
Auxilary equipment	106.06	9
Water heating	76.21	7
Space cooling	73.37	6
Total	**1171.91**	**100**

* Excludes street lighting

FIGURE 4-3: Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Estimated energy use without energy efficiency improvements	1.00	1.05	1.08	1.13	1.13	1.16	1.19	1.19	1.16	1.21	1.26	1.25	1.33	1.37
Actual energy use	1.00	1.03	1.04	1.08	1.07	1.11	1.13	1.15	1.09	1.13	1.24	1.22	1.31	1.36

FIGURE 4-4: Energy Use in Commercial Buildings

	Gigajoules per m^2 per year
CBIP results	0.85
Model National Energy Code for Buildings	1.32
New buildings*	1.33
All buildings *	1.59

* Source: Commerical and Institutional Building Energy Use Survey (CIBEUS), 2000. Estimates relate only to the surveyed area of populations over 175 000, and in Atlantic Canada to populations over 50 000.

FIGURE 4-5: Estimated Average GHG Reductions by Type of Institution Under CBIP, 2004

Building type	Number	Annual GHG Savings* (tonnes/year)	Average GHG savings (tonnes/year) 2004
Municipal	15	1644	110
Retail	103	18 549	180
MURB	34	5600	182
Office	110	21 214	195
Education	166	33 265	200
Other	27	5512	204
Health	70	17 580	251
Industrial	16	4653	291
Total	**541**	**108 016**	

* for average size building

FIGURE 5-1: Industrial Energy Use by Sub-Sector, 2003

	Percent of Industrial Energy Use
Pulp and paper	26.2
Mining	19.4
Other manufacturing	17.4
Petroleum refining	11.6
Smelting and refining	8.1
Iron and steel	7.2
Chemicals	5.9
Cement	1.9
Construction	1.7
Forestry	0.6

FIGURE 5-2: Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2003

Industry	Energy Cost / Total Production Cost
Cement	38.49
Pulp and paper	13.91
Chemicals	13.25
Iron and steel	12.85
Aluminum	12.50
Petroleum refining	2.41
Transportation equipment manufacturing	0.86

FIGURE 5-3: Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
Estimated energy use without energy efficiency improvements	1.00	1.15	1.16	1.20	1.21	1.26	1.31	1.27	1.30	1.32
Actual energy use	1.00	1.07	1.10	1.10	1.08	1.11	1.15	1.10	1.16	1.19

FIGURE 5-4: CIPEC Energy Intensity Index, 1990 to 2003

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Energy Intensity Index	1.00	1.05	1.08	1.06	1.06	1.04	1.03	0.98	0.96	0.95	0.91	0.91	0.92	0.91

FIGURE 5-5: Industrial Energy Innovators, 1995–1996 to 2004–2005

	1995–1996	1996–1997	1997–1998	1998–1999	1999–2000	2000–2001	2001–2002	2002–2003	2003–2004	2004–2005
Number of Industrial Energy Innovators	176	203	208	212	227	280	305	382	529	653

FIGURE 6-1: Transportation Energy Use by Mode, 2003

	Energy Use (PJ)	Percentage
Passenger light vehicle	1055.5	44.7
Freight truck	757.8	32.1
Passenger aviation	211.9	9.0
Freight marine	103.1	4.4
Off-road	93.1	3.9
Freight rail	71.2	3.0
Passenger bus	52.4	2.2
Freight aviation	13.8	0.6
Passenger rail	2.6	0.1
Total	**2361.3**	**100.0**

FIGURE 6-2: Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2003

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Estimated energy use without energy efficiency improvements	1.00	0.97	1.01	1.05	1.11	1.15	1.17	1.22	1.26	1.30	1.32	1.32	1.36	1.41
Actual energy use	1.00	0.96	0.99	1.00	1.05	1.07	1.09	1.13	1.17	1.20	1.22	1.21	1.23	1.26

FIGURE 6-3: Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2003

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Passenger car market share (%)	72.1	72.7	70.9	67.7	65.7	63.5	61.1	58.0	57.3	59.3	60.6	62.7	62.1	61.6
Passenger light truck market share (%)	27.9	27.3	29.1	32.3	34.3	36.5	38.9	42.0	42.7	40.7	39.4	37.3	37.9	38.4

FIGURE 6-4: New Car Fuel Efficiency, Normalized for Weight and Power, 1990 to 2003

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
L/100 km	1.00	0.98	0.99	0.99	1.00	0.96	0.96	0.98	0.96	0.96	0.95	0.95	0.94	0.93
L/100 km/kg	1.00	1.00	1.01	0.99	0.96	0.91	0.92	0.93	0.92	0.91	0.90	0.89	0.87	0.86
L/100 km/hp	1.00	0.98	0.95	0.93	0.91	0.85	0.82	0.82	0.79	0.79	0.76	0.75	0.73	0.71

FIGURE 6-5: Trucking Intensity and Average Activity per Truck, 1990 to 2003

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Activity (tkm/truck)	113 598	102 723	103 801	115 315	131 042	138 426	150 912	157 785	157 395	192 004	199 674	200 876	201 773	220 489
Energy Intensity (MJ/tkm)	3.65	3.74	3.73	3.54	3.34	3.37	3.24	3.25	3.10	2.83	2.86	2.73	2.72	2.67

FIGURE 6-6: Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards, 1990 to 2004

Truck Model Year	Truck Standard (11.4 L/100 km)	Trucks CAFC	Car Standard (8.6 L/100 km)	Cars CAFC
1990	11.8	11.4	8.6	8.2
1991	11.6	11.1	8.6	8.0
1992	11.6	11.3	8.6	8.1
1993	11.5	11.1	8.6	8.1
1994	11.5	11.5	8.6	8.2
1995	11.4	11.5	8.6	7.9
1996	11.4	11.3	8.6	7.9
1997	11.4	11.3	8.6	8.0
1998	11.4	11.4	8.6	7.9
1999	11.4	11.3	8.6	7.9
2000	11.4	11.1	8.6	7.8
2001	11.4	11.0	8.6	7.8
2002	11.4	10.9	8.6	7.7
2003	11.4	10.7	8.6	7.6
2004	11.4	10.7	8.6	7.6

FIGURE 6-7: Vehicle Fuel Efficiency Awareness – EnerGuide Labels

Year	New vehicles on lot with EnerGuide label (%)	New vehicles in showroom with EnerGuide label (%)
1999	64	47
2001	77	56

FIGURE 6-8: Vehicle Fuel Efficiency Awareness – Program Activities

Year	Recollection of information on how to reduce vehicle fuel consumption (general public) (%)	Awareness of program activities (general public) (%)
1998	30	9
2002	36	16

FIGURE 6-9: Drivers Trained and Participation in the Fleet Vehicle Initiative*, 1997–1999 to 2003–2004

	Drivers Trained	Members
1997–1999	51 000	946
1999–2000	53 000	1068
2000–2001	112 846	1643
2001–2002	125 000	2707
2002–2003	149 000	2805
2003–2004	160 000	3267

* Currently updating all information in the membership database (more than 3800 entries) to ensure performance indicator consistency and accuracy. Drivers trained estimate should be considered only as a preliminary result.

FIGURE 7-1: Canadian Wind Power Capacity, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Wind Power Capacity (MW)	0	0	0	19	19	20	20	21	24	124	137	214	230	327	444

FIGURE 8-1: GHG Emissions Reductions From Federal Operations, 1990 to 2010

	1990	1998	2000	2001	2002	2010 Target
GHG Emissions (kt of CO_2e)	3925	3164	3044	2973	2968	2724

FIGURE 8-2: Annual Energy Savings From the ETAG, 1991–1992 to 2004–2005

	1991–1992	1992–1993	1993–1994	1994–1995	1995–1996	1996–1997	1997–1998	1998–1999	1999–2000	2000–2001	2001–2002	2002–2003	2003–2004	2004–2005
Annual additions	20	50	40	70	90	80	77	77	93	103	112	117	110	110
Annual (cumulative)	20	70	110	180	270	350	427	504	597	700	812	929	1039	1149

FIGURE 8-3: Federal Fleet Size and Fuel Consumption, 1995–1996 to 2003–2004

	1995–1996	1997–1998	1999–2000	2001–2002	2002–2003	2003–2004
Vehicles	24 854	22 796	22 462	23 313	26 233	26 233
Litres of gasoline equivalent (thousands)	88 725	75 684	78 281	63 300	68 619	73 616

FIGURE 8-4: Purchases of Alternative Fuel Vehicles (Including Hybrids) for the Federal Fleet, 1997–1998 to 2004–2005

	1997–1998	1998–1999	1999–2000	2000–2001	2001–2002	2002–2003	2003–2004	2004–2005
Annual purchases	131	161	181	180	126	489	293	682

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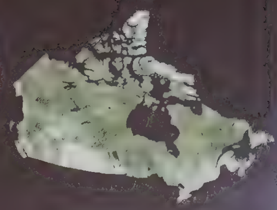

Improving Energy Performance in Canada

Report to Parliament Under the *Energy Efficiency Act*
For the Fiscal Year 2005–2006

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The digital mosaic of Canada that appears on the cover of this publication is produced by Natural Resources Canada (Canada Centre for Remote Sensing) and is a composite of individual satellite images. The differences in the density of vegetation are illustrated through shading.

Published by the authority of the Minister of Natural Resources
Government of Canada

Aussi disponible en français sous le titre :
Améliorer le rendement énergétique au Canada –
Rapport au Parlement en vertu de la *Loi sur l'efficacité énergétique*, pour l'année financière 2005-2006

Cat. No. M141-10/2006E
ISBN 978-0-662-44053-6

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Her Excellency the Right Honourable Michaëlle Jean
C.C., C.M.M., C.O.M., C.D.
Governor General and Commander-in-Chief of Canada

Your Excellency,

I have the honour to present the *Report to Parliament Under the* Energy Efficiency Act for the fiscal year ending March 31, 2006, in accordance with Section 36 of the Act.

Respectfully submitted,

The Honourable Gary Lunn
Minister of Natural Resources

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Minister's Foreword

This Report to Parliament describes our Government's efforts to promote new energy technologies, clean energy sources and energy efficiency.

As Canada emerges as an energy superpower, our next challenge is to become a clean energy superpower. To do this, we must address the fact that the greatest source of untapped energy is the energy we waste. We must also increase our use of renewable energy and our investment in science and technology to make conventional energy cleaner.

Over the coming year, we will implement our ecoENERGY Initiatives. Investments in science and technology will make it possible to use clean energy technologies to reduce greenhouse gas emissions and smog. Investments in renewable energy will offer cleaner and more diversified energy choices to Canadians. Finally, energy-efficiency programs and regulations will give Canadians the tools they need to make informed choices to protect and improve the environment in their daily activities.

The production and use of energy are just two areas in which this Government is taking decisive action. By introducing the Clean Air Act, Canada's New Government created a comprehensive and integrated approach to tackling air pollution and greenhouse gases. This Act will regulate emissions from every sector in Canada for the first time in history. Our Government will work with all stakeholders to implement this commitment in a fair, effective and timely manner.

Also included in the Clean Air Act are amendments to Canada's energy-efficiency regulations. The proposed new regulatory requirements will affect the energy efficiency of 30 products, such as traffic signals, battery chargers and commercial clothes washers.

These proposed amendments will help Canada remain a world leader in the number of products that are regulated for energy efficiency. New standards will have energy savings equivalent to the energy usage in all households in a city the size of Windsor, Ontario.

The Government of Canada is committed to making real progress on reducing emissions and providing cleaner air to benefit all Canadians.

The Honourable Gary Lunn, P.C., M.P.
Minister of Natural Resources

Executive Summary

Canadians spent almost $135 billion in 2004 on energy to heat and cool their homes and offices and to operate their appliances, cars and industrial processes. Several factors contribute to Canadian energy demand: a vast geography, a northern climate with extreme seasonal variations in temperature, and an economy founded on an abundance of natural resources.

Types of Energy Use

There are two general types of energy use: primary and secondary. Primary use comprises Canada's total consumption, including energy required to transform one form to another – such as coal to electricity – and to deliver energy to consumers. Secondary use comprises energy consumed for residential, commercial/institutional, industrial, transportation and agricultural purposes.

Key highlights in energy use include the following:

- Between 1990 and 2004, the latest year for which figures are available, primary energy use increased by 27.9 percent.
- In 2004, secondary use accounted for 68.5 percent of primary energy use and produced 66.6 percent (505 megatonnes) of Canada's total greenhouse gas (GHG) emissions. This last figure includes emissions produced by utilities in meeting the demand for electricity.
- Without improvements in energy efficiency made to buildings and equipment and the changes in the behaviour of energy users during the past several decades, the increases in energy use would have been much higher.

The industrial sector consumes the most energy, accounting for 38.4 percent of total secondary energy use in 2004. Transportation is second (28.9 percent), followed by residential (16.6 percent), commercial/institutional (13.7 percent) and agriculture (2.4 percent).

Promoting Energy Efficiency

For the past decade, Natural Resources Canada (NRCan) has promoted energy efficiency and the use of alternative energy as a means to reduce GHG emissions and save money. NRCan uses a broad range of policy instruments, including leadership, information, voluntary actions, financial incentives, research and development, and regulation.

The *Energy Efficiency Act*, which came into force in 1992, provides for the making and enforcement of regulations concerning minimum energy performance levels for energy-using products, as well as the labelling of energy-using products and the collection of data on energy use. The *Energy Efficiency Regulations* are described in Chapter 2.

Energy Intensity / Energy Efficiency

As explained in Chapter 1, although aggregate energy intensity is sometimes used as a proxy for energy efficiency, there is a difference between the two terms. Understanding this difference is important when comparing Canada with other countries. Energy intensity is a broader measure, capturing not only energy efficiency but also impacts such as those of weather variations and changes in the structure of the economy. While Canada has a higher aggregate intensity than most International Energy Agency (IEA) countries, it has made significant overall improvements in energy efficiency. According to a recent IEA report[1] that examined 13 countries, Canada has the fourth fastest rate of energy efficiency improvement.

[1] International Energy Agency, *Oil Crises and Climate Challenges – 30 Years of Energy Use in IEA Countries*, Paris, 2004.

Evidence of Change

As explained in this report, recent growth in energy use is primarily due to increased activity in various sectors; however, this growth would have been far greater without improvements in energy efficiency. As reported in Chapter 1, energy efficiency improvements made between 1990 and 2004 are estimated to have reduced GHG emissions by almost 53.6 megatonnes and decreased energy expenditures by an average of $14.5 billion in 2004 alone.

Over this period, the residential sector recorded a 21.0 percent increase in energy efficiency. The figures for transportation (17.6 percent), industry (11.5 percent) and the commercial/institutional (0.4 percent) sectors demonstrate that improvements in energy efficiency are being made throughout the economy.

Through improvements in energy efficiency, Canadians can reduce the size of their energy bills and achieve important environmental goals. Over the short term, changes to less GHG-intensive fuels (e.g. from coal to natural gas) can help reduce GHG emissions. However, over the long term, reducing GHG emissions further will require more widespread use of alternative energy.

In recent years, the production of energy derived from alternative sources has increased significantly. Between 1990 and 2003, the last year for which data are available, the amount of electricity generated from the sun, wind and biomass increased by 302 percent.

Engaging Canadians

To maximize the effectiveness of its initiatives, NRCan engages a growing number of partners from the private and public sectors. Dozens of cooperative agreements are in place with a broad range of businesses, community groups and other levels of government.

These initiatives engage Canadian society, along with every sector of the economy, in new and more efficient approaches to secondary energy use and in the development and deployment of renewable energy sources.

This report provides an overview of the work being done in each sector, highlights NRCan's efficiency and alternative energy (EAE) programs, and lists their key achievements for 2005–2006. All programs are described in the corresponding sector chapter. Program entries for market transformation programs also include quantitative performance indicators in graph or table format (see below). A list of NRCan's EAE initiatives and expenditures appears in Appendix 1.

Performance Indicators Highlighted in the Report

Equipment, Standards and Labelling

- Volume of Monthly Import Documents
- Estimated Impact of *Energy Efficiency Regulations*, 2010 and 2020 (aggregate annual savings)
- ENERGY STAR® Qualified Appliances as a Percentage of Total Category Sales in Canada, 1999 to 2004
- ENERGY STAR Awareness Levels in Canada, 2005

Housing

- Annual Heating Consumption for Houses Constructed to Different Standards
- Average Energy Consumption per Household, Pre-1946 to 2001–2006 Construction
- Average Energy Consumption of New Appliances, 1990 and 2004 Models
- Number of Eligible R-2000 Housing Starts, 1990 to 2005
- National Trends in Air Leakage in Houses, Pre-1945 to 2000–2006 Construction
- Evaluations Under EnerGuide for Houses, 1998 to 2005
- Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2006

Buildings

- Energy Use in Commercial Buildings, 2005
- Estimated Average Energy Savings by Type of Building Under the Commercial Building Incentive Program, 2005
- EnerGuide for Existing Buildings – Incentive Retrofit Projects, 1998 to 2005

Industry

- CIPEC Energy Intensity Index, 1990 to 2004
- Estimated CIPEC Energy Savings, 2001 to 2005
- Industrial Dollars to $ense Participants, 1997 to 2005

Transportation

- Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards, 1990 to 2005
- Vehicle Fuel Efficiency – EnerGuide Labelling
- Vehicle Fuel Efficiency Awareness – Program Activities
- Number of Idling Reduction Devices Purchased and Claimed Under the Commercial Transportation Energy Efficiency Rebate (CTEER) Initiative
- Participation in the Fleet Vehicles Initiative, 1998 to 2005
- Drivers Trained, 1998 to 2004

Renewable Energy

- Electricity Generation Capacity From Renewable Sources (Includes Hydro)
- Canadian Wind Power Capacity, 1990 to 2005
- REDI for Business Projects Completed, 1998 to 2005

Federal House in Order

- GHG Emissions Reductions From Federal Operations, 1990 to 2010
- Annual Energy Savings From Energy Technology Applications Group, 1991 to 2005
- Federal Fleet Size and Fuel Consumption, 1995 to 2004
- Purchases of Alternative Fuel Vehicles (Including Hybrids) for the Federal Fleet, 1997 to 2004

Introduction

Natural Resources Canada's Efficiency and Alternative Energy Program

Since the early 1990s, Natural Resources Canada (NRCan) has emphasized the promotion of energy efficiency and the use of alternative energy (i.e. alternative transportation fuels and renewable energy) as a means to reduce greenhouse gas (GHG) emissions and improve the Canadian economy.

A complete list of NRCan's efficiency and alternative energy (EAE) initiatives in 2005–2006 is provided in Appendix 1. These initiatives engage Canadian society and all major sectors of the economy in new and more advanced approaches to secondary energy use – i.e. to the consumption of energy in the residential, commercial/institutional, industrial and transportation sectors.

NRCan's EAE initiatives are managed by

- the Office of Energy Efficiency, which delivers market transformation initiatives to improve energy efficiency and the use of alternative transportation fuels;
- the CANMET[1] Energy Technology Centre and the Mineral Technology Branch, which deliver EAE research, development and demonstration (R,D&D) initiatives;
- the Electricity Resources Branch, which delivers market transformation initiatives for renewable energy; and
- the Science Branch of the Canadian Forest Service, which undertakes research and development (R&D) in the use of forest biomass for energy.

In its efforts to improve energy efficiency and increase the use of alternative energy, NRCan emphasizes partnership and cooperation with stakeholders such as other levels of government, the private sector and non-governmental organizations. With this approach, the demand side of the energy market moves toward more energy-efficient capital stock, production processes and operating practices without reducing service or comfort levels. On the supply side, Canada participates in developing technology for tapping renewable energy resources and alternative transportation fuels as well as for increasing the energy efficiency of energy production.

[1] CANMET is the Canada Centre for Mineral and Energy Technology.

Policy Instruments

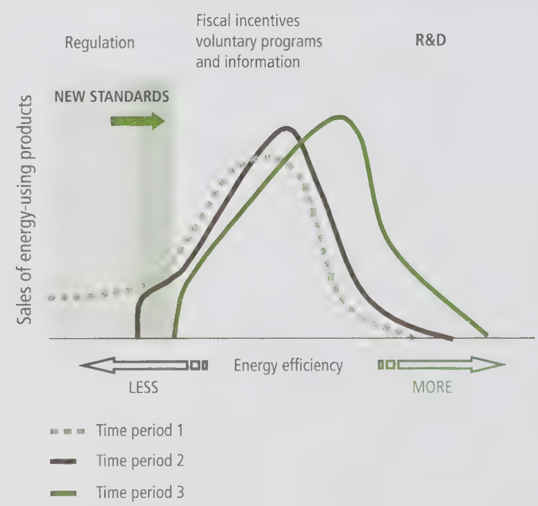
NRCan's key policy instruments are as follows:

- regulation
- financial incentives
- leadership
- information
- voluntary initiatives
- research, development and demonstration

Figure 1 shows how these policy tools work together to increase energy efficiency, i.e. how they help to reduce the amount of energy needed to obtain a certain level of service. Energy performance regulations eliminate less efficient products from the market. Fiscal incentives, voluntary programs and information increase the take-up of existing opportunities to use energy more efficiently. R&D increases the opportunities for achieving greater levels of efficiency in a particular type of energy use.

FIGURE 1

Moving the Market



Regulation

The *Energy Efficiency Act* gives the Government of Canada the authority to make and enforce regulations, primarily for the purpose of establishing performance and labelling requirements for energy-using products, doors and windows that are imported or shipped across provincial borders.

Financial Incentives

NRCan uses financial incentives to encourage final users of energy to employ energy efficiency and renewable energy technologies and practices. NRCan also offers financial incentives for wind energy, ethanol plants, natural gas vehicles and refuelling infrastructure.

Leadership

Leadership means setting an example for other levels of government and for the private sector by increasing energy efficiency and the use of alternative energy in the Government of Canada's operations.

Information

NRCan disseminates information to consumers, using methods that range from broad distribution to individual consultations with clients, to increase awareness of the environmental impact of energy use and to encourage consumers to become more energy efficient and make greater use of alternative energy sources. Activities include publications, exhibits, advertising, toll-free lines, conferences, Web sites, workshops, training, building design software and promotional products.

Voluntary Initiatives

Companies and institutions work with NRCan on a voluntary basis to establish and achieve energy efficiency objectives. NRCan's voluntary EAE initiatives target large consumers of energy in the commercial/institutional and industrial sectors and organizations whose products are important determinants of energy use. The initiatives involve industry-government agreements and, for groups of large industrial energy users, energy efficiency target setting. NRCan provides a variety of support services to assist and stimulate action by companies and institutions on energy efficiency, including developing standards and training.

Research, Development and Demonstration

NRCan's EAE initiatives support the development and dissemination of more energy-efficient equipment, processes and technologies, and alternative energy technologies. R&D also provides the scientific knowledge needed to develop the technologies, codes, standards and regulations required for the sustainable use of energy.

NRCan provides national leadership in energy science and technology (S&T) by undertaking in-house research in its own laboratories, contracting out research activities to other organizations and carrying out the federal funding initiatives listed in Chapter 9, which are the only federal interdepartmental S&T investment funds with a focus on the energy sector and its economic and environmental effects.

Measuring Progress

The primary goal of NRCan's EAE initiatives is to change energy consumption patterns to obtain environmental and economic benefits. Part of assessing program progress and performance involves considering both program delivery and program effectiveness.

NRCan monitors and tracks the following three aspects of program delivery:

- program outputs
- program outcomes
- market outcomes

Program outputs are the items produced regularly, such as information and marketing materials, demonstration projects, financial incentives and regulations. Program outputs are designed to lead to **program outcomes** – namely, changes in the behaviour of groups targeted by a program. These groups may be either energy users or producers of energy-using equipment or structures. For example, program outcomes occur when consumers purchase more energy-efficient appliances than they would have if there were no program. Other important factors that influence consumer behaviour include product price, household income, personal taste and other government and non-government programs.

Since program outcomes can directly affect the amount and type of energy consumed in the market, they contribute, in part, to observable **market outcomes**. Market outcomes ultimately reflect the impacts of NRCan programs on changes in energy efficiency, energy intensity, GHG emissions and the use of alternative energy. In this sense, achievement of a targeted market outcome, or observable progress towards a market outcome, serves as an indicator of program effectiveness. An example of a program outcome leading to a market outcome is a

householder's purchase of a more energy-efficient appliance, resulting in reduced use of electricity. Depending on the source of electricity and how the utility changes its electricity-generating methods to meet the change in demand resulting from reduced electricity use, this could also lead to a decline in GHG emissions.

Data Collection and Analysis

In 1991, NRCan launched the National Energy Use Database (NEUD) initiative to help the department improve its knowledge of energy consumption and energy efficiency at the end-use level in Canada and to support NRCan's analytical expertise. The NEUD initiative plays a number of crucial roles directly related to NRCan program activities; however, its most important role is to secure the development of a reliable, Canada-wide information base on energy consumption at the end-use level for all energy-consuming sectors.

The NEUD initiative consists of several broad components that typically involve conducting large- and small-scale surveys of the stocks and characteristics of energy-using equipment and buildings (both commercial/institutional buildings and residential dwellings), observing Canadians' behaviour with respect to energy use, monitoring the adoption of new technologies in the marketplace, and participating in the development of energy end-use data and analysis centres (DACs) across Canada.

The main objective of the DACs is to create a base of expertise for the analysis of energy consumption at the end-use level in Canada. The DACs are mandated to improve the accessibility and comparability of existing data on the evolution of energy consumption and its impact on environmental quality. Three DACs currently exist: the transportation centre at Université Laval in Québec City, Quebec; the industrial centre at Simon Fraser University in Burnaby, British Columbia; and the buildings centre at the University of Alberta in Edmonton, Alberta.

The centres have made significant contributions to NEUD's mandate of improving knowledge of energy consumption and energy efficiency at the end-use level in Canada. For example, the transportation centre at Université Laval and the industrial centre at Simon Fraser University used a discrete choice model in 2005–2006 to analyse consumers' preferences for personal vehicles when they are faced with new technologies and alternative fuels. The results will be used to forecast the adoption of new technologies and alternative fuels, and the potential reductions in energy use and GHG emissions.

GHG Emissions and Climate Change

Climate change is a global challenge arising from the continuing buildup in levels of anthropogenic (human-produced) GHGs in the atmosphere in addition to naturally occurring emissions. GHGs are composed of a number of gases, and the main source of anthropogenic emissions is the combustion of fossil fuels. Substantially reducing GHG emissions is a challenge, particularly given Canada's highly industrialized and resource-based economy. Solutions require a multifaceted, coordinated domestic response and a high level of cooperation among all nations.

In This Report

This thirteenth annual Report to Parliament focuses principally on EAE initiatives that address secondary energy use. Trends in energy use and GHG emissions in Canada are discussed in Chapter 1. Chapter 2 discusses the equipment regulations under the *Energy Efficiency Act* and equipment labelling activities. Chapters 3 to 6 review individual EAE initiatives to improve energy use in housing, buildings, industry and transportation, highlighting their achievements and progress indicators. Chapter 7 deals with renewable energy sources and use. Chapter 8 describes the Government of Canada's actions to improve its own use of energy. Chapter 9 describes general programs not specific to EAE initiatives discussed in Chapters 3 to 7. The final chapter describes domestic and international cooperation in EAE. Appendix 1 contains information on NRCan's EAE expenditures. Appendix 2 contains detailed information on the data presented in this report.

Chapter 1: Trends in Energy Use

Introduction

Canadians enjoy an abundance of energy from a variety of sources. This comparative advantage in the supply of energy helps Canadians deal with the economic disadvantages of small domestic markets, long distances, rugged geography and a relatively harsh climate. It has also fostered the development of industries that have a particularly strong energy demand.

Canadians spent almost $135 billion in 2004 on energy to heat and cool their homes and offices and to operate their appliances, cars and industrial processes. This represents 12.9 percent of the country's gross domestic product (GDP).

Energy Use and Greenhouse Gas Emissions

There are two general types of energy use: primary and secondary. Primary energy use encompasses the total requirements for all users of energy, the energy required to transform one energy form to another (e.g. coal to electricity) and the energy used to bring energy supplies to the consumer. Secondary energy use is energy used by final consumers for residential, commercial/institutional, industrial, transportation and agricultural purposes.

Primary energy use in Canada today reflects changes over several decades in energy-consuming equipment and buildings and in the behaviour of energy users. Primary energy use increased by 27.9 percent between 1990 and 2004, from 9743 petajoules to 12 463 petajoules.

Secondary energy use (8543 petajoules) accounted for 68.5 percent of primary energy use in 2004. It was responsible for 66.6 percent (505 megatonnes) of total greenhouse gas (GHG) emissions in Canada, if indirect emissions – namely, those produced by electric utilities to meet end-use electrical demand – are included.

This report deals with energy-related GHG emissions, which comprise carbon dioxide (CO_2), methane and nitrous oxide. CO_2 accounts for most of Canada's GHG emissions. All subsequent references in this report to CO_2 and GHGs include emissions that are attributable directly to secondary energy use and indirect emissions attributable to electricity generation, unless otherwise specified.

From 1990 to 2004, secondary energy use increased by 22.9 percent and related GHG emissions increased by 23.9 percent. The GHG intensity of energy changed slightly during the period as fuel switching towards less GHG-intensive fuels offset a higher GHG intensity in electricity production. The industrial sector is the largest energy user, accounting for 38.4 percent of total secondary energy use in 2004. The transportation sector is the second largest energy user at 28.9 percent, followed by the residential sector at 16.6 percent, the commercial/institutional sector at 13.7 percent and the agriculture sector at 2.4 percent.

Energy Intensity / Energy Efficiency

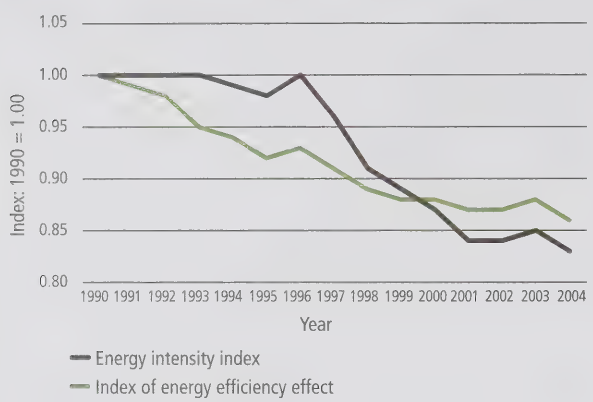
Aggregate energy intensity is the ratio of energy use per unit of GDP or, alternatively, energy use per capita. Aggregate energy intensity is sometimes used as a proxy for energy efficiency because it is simple and straightforward and the data for the calculation are readily available. However, this measure is misleading because, in addition to pure energy efficiency, intensity captures impacts such as weather variations and changes in the structure of the economy.

To properly gauge changes in energy efficiency over time, differences in economic structure and weather need to be normalized or factored out of the intensity calculation. Natural Resources Canada's (NRCan's) Office of Energy Efficiency (OEE) applies an internationally recognized factorization analysis technique to isolate the impact of energy efficiency on changes in Canadian energy use.

Figure 1-1 compares, for Canada, an index of annual variation in energy intensity with the OEE's index of changes in energy efficiency over the period 1990 to 2004. The indexes present improvements in energy intensity and efficiency as a downward trend.

FIGURE 1-1

Energy Intensity and the Energy Efficiency Effect, 1990 to 2004



International Comparisons

Canada has a higher aggregate intensity – absolute energy use per capita or per unit of GDP – than most International Energy Agency (IEA) countries, ranking second and fourth, respectively.

Meaningful comparisons of energy efficiency between countries can be difficult because very detailed energy, equipment stock, production and/or weather data for each target country are required.

However, according to a recent IEA report entitled *Oil Crises and Climate Challenges – 30 Years of Energy Use in IEA Countries*, Canada's energy efficiency improved at an average annual rate of 1 percent between 1990 and 1998. This rate was similar to that of the United States and was the fourth fastest rate among the 13 countries included in the report (surpassed by the Czech Republic, Hungary and Turkey).

TABLE 1-1

Energy Intensities for Selected IEA Countries, 2003

	GJ* per capita		GJ* per $1,000 of GDP**
Luxembourg	375.4	Czech Republic	18.5
Canada	261.4	Hungary	15.4
United States	226.0	Turkey	11.9
Finland	210.8	Canada	10.8
Norway	192.0	Korea	10.0
Belgium	172.2	New Zealand	9.5
Sweden	167.3	Finland	8.7
Netherlands	160.3	Portugal	8.1
Australia	151.2	Luxembourg	8.0
New Zealand	137.8	Belgium	7.6

*Gigajoules

**GDP is in constant 1995 US$ converted at exchange rate

Trends in Energy Efficiency

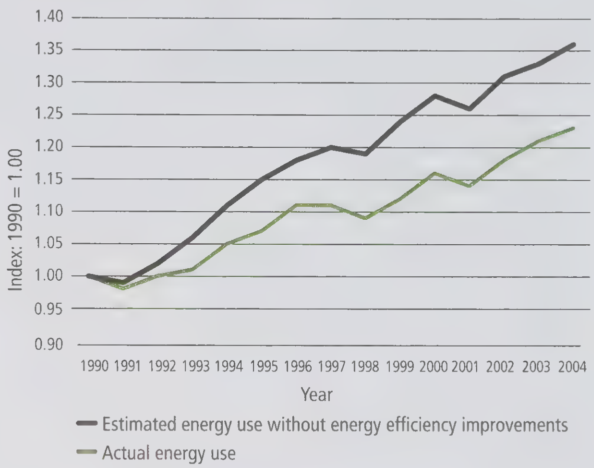
Every year, NRCan publishes *Energy Efficiency Trends in Canada*, which reports on changes in energy use (and GHG emissions) and the contribution of the following key factors to these changes:

- Increases in sector **activity** lead to increased energy use and emissions. In the residential sector, for example, an increase in the number of households results in increased energy use.
- Fluctuations in **weather** lead to changes in space-heating and space-cooling requirements. A colder winter or a warmer summer can lead to increased energy use.
- A shift in the **structure** of activity toward more energy-intensive components of activity leads to increased energy use and emissions. For example, if the distribution of activity in the industrial sector shifts from forestry to the iron and steel industry, industrial energy use will increase because the former sector is less energy intensive than the latter.
- A higher **service level** for auxiliary equipment (e.g. computers, fax machines and photocopiers) increases energy use and emissions. This factor is only applied to commercial/institutional buildings. During the 1990s, these types of equipment were widely adopted; however, improvements in functionality increased productivity and moderated increases in energy consumption owing to the use of more machines.
- **Energy efficiency** refers to how effectively energy is being used – for example, how long an appliance can be operated with a given amount of energy.

In this report, changes in energy efficiency are the net result after allowing for the changes in energy use due to changes in activity, weather, structure and service level. To the extent that other factors that affect energy use have not been captured, this measure of energy efficiency improvement may overstate or understate the "actual" change. For example, in the industrial sector, in an industry such as other manufacturing, there may have been changes in energy use due to shifts in the mix of products, but this is not captured.

FIGURE 1-2

Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004



Secondary energy use increased between 1990 and 2004 (from 6951 to 8543 petajoules). Without improvements in energy efficiency, increases attributable to activity, weather, structure and service level would have led to an increase in secondary energy use of 35.9 percent. However, as a result of a 13.6 percent (903 petajoules) improvement in energy efficiency,[1] actual secondary energy use increased by 22.9 percent to 8543 petajoules.

The change in energy use between 1990 and 2004, actual and without energy efficiency improvements, is shown in Figure 1-2. The difference in energy use due to energy efficiency – the estimated energy saving – represents a reduction in energy costs of $14.5 billion in 2004 and a reduction in GHG emissions of almost 54 megatonnes. Changes in energy efficiency are estimated for each of the four major end-use sectors and are presented in Chapters 3 to 6. The energy efficiency improvements were largest in the residential sector (21.0 percent), followed by the transportation sector (17.6 percent), industrial sector (11.5 percent), and commercial/institutional sector (0.4 percent).[2]

[1] Based on the OEE Index.

[2] The aggregate energy-use data presented in this report are taken from Statistics Canada's *Report on Energy Supply-Demand in Canada* (RESD). Differences exist between this report and *Canada's Emissions Outlook: An Update* (CEO Update) concerning the sector allocations of RESD energy use data. The CEO Update's sector allocation is based on Environment Canada's *Trends in Canada's Greenhouse Gas Emissions 1990–1997*, whereas this report uses a definition better suited for energy end-use analysis. Some modifications to the original Statistics Canada data were required and are documented in Appendix A of Natural Resources Canada's *Energy Use Data Handbook, 1990 and 1997 to 2004.*

TABLE 1-2

Explanation of Changes in Secondary Energy Use, 1990 to 2004

	Sectors					
	Residential	Commercial/ Institutional	Industrial	Transportation	Total**	% Change
1990 energy use (PJ)*	1289.4	867.0	2717.4	1877.9	6950.8	
2004 energy use (PJ)	1420.8	1171.2	3277.5	2465.1	8543.3	
Change in energy use (PJ)	131.5	304.2	560.1	587.2	1592.5	22.9%
Explanatory factor (change due to)						
Activity	331.02	218.55	1097.78	669.98	2317.33	33.3%
Weather	25.56	10.95	n/a	n/a	36.51	0.5%
Structure	45.96	3.26	–223.86	197.43	22.80	0.3%
Service level	n/a	75.47	n/a	n/a	75.47	1.1%
Energy efficiency	–271.06	–3.05	–313.86	–314.69	–902.66	–13.0%
Other factors		–1.01		34.49	43.03	0.6%

*Petajoules

**Total also includes energy use for agriculture (not shown in table)

Trends in Renewable Energy

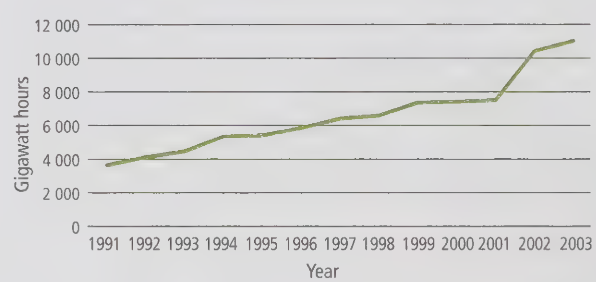
As previously noted, changes in the fuel mix used by the Canadian economy can reduce GHG intensity. Although over the near term this can be achieved by moving from more to less GHG-intensive fuels (e.g. from coal to natural gas), over the longer term the use of renewable energy sources is expected to accelerate this trend.

Figure 1-3 shows the trend in the use of electricity generated non-hydro renewable energy sources such as wind, solar and biomass in Canada, indicating a 302 percent increase over the period 1991–2003. Although representing only a small component of overall electricity use, the proportion of electricity generated from these renewable energy sources increased from 0.8 percent to 1.9 percent over the same period, representing a 257 percent increase in its share. While most of this production was derived from biomass, the share of wind power is increasing rapidly.

The graph does not include hydro sources, either conventional or small (less than 50 megawatts). The former accounts for 58.6 percent of electricity generated in Canada; installed capacity is about 68 gigawatts. The small hydro installed generating capacity of 3300 megawatts provided about 2 percent of electricity generated in Canada.

FIGURE 1-3

Electricity Production From Non-Hydro Renewable Sources, 1991 to 2003



Chapter 2: Equipment, Standards and Labelling

Introduction

Natural Resources Canada's (NRCan's) wide range of energy efficiency initiatives includes Canada's *Energy Efficiency Regulations*, standards and labelling programs.

The *Energy Efficiency Act*, which came into force in 1992, gives the Government of Canada the authority to make and enforce regulations on performance and labelling requirements for energy-using products that are imported into Canada or shipped across provincial borders for the purpose of sale or lease.

The first *Energy Efficiency Regulations* came into effect in February 1995, following extensive consultations with provincial governments, affected industries, utilities, environmental groups and others. The Regulations refer to national consensus performance standards developed by accredited standards writing organizations such as the Canadian Standards Association. Such standards include testing procedures that must be used to determine a product's energy performance. Regulated products that fail to meet the minimum performance levels identified by the Regulations cannot be imported into Canada or traded interprovincially.

Through the Accelerated Standards Action Program, NRCan works with key stakeholders to improve standards development and approval processes and accelerate the market penetration of high-efficiency residential, commercial and industrial equipment.

Regulations have now been established for more than 30 products that consume 71 percent of the energy used in the residential sector in Canada and 50 percent of the energy used in the commercial/institutional sector. Regulated products include major household appliances, water heaters, heating and air-conditioning equipment, automatic icemakers, dehumidifiers, dry-type transformers, electric motors of 1 to 200 horsepower and certain lighting products. The Regulations apply to these products even if they are incorporated into a larger unit or machine that is not regulated.

NRCan regularly amends the Regulations to strengthen the minimum energy performance requirements for prescribed products in situations where the market has been transformed to a higher level of efficiency. The Regulations are also amended occasionally to add new products, harmonize minimum energy performance requirements with those of other jurisdictions, and update testing methodologies or labelling requirements. Finally, regulations may be established for gathering market data on the energy performance of certain types of equipment. In the case of gas fireplaces, for example, the data gathered is used to support programs developed by the industry and NRCan and its partners for gas fireplace performance.

Before adding a new product or otherwise amending the Regulations, NRCan conducts studies to analyse how the proposed change will affect the market. For example, it checks if it will have a measurable impact on energy efficiency levels without imposing undue hardship on manufacturers. A key criterion for amending the Regulations is that the change must have a significant positive impact on consumers and the environment. Stakeholders are consulted on all proposed changes to the Act and Regulations as well as on their practical application in the marketplace. During the period covered by this report, for example, significant analysis and consultation was conducted on new proposed standards for vending machines and commercial refrigeration products, on increased stringency of standards for residential and commercial air conditioners, and on proposals for broadening the scope of standards for refrigerators and transformers. Other administrative revisions were also discussed with affected stakeholders.

Canada's *Energy Efficiency Act* and *Energy Efficiency Regulations* support a number of labelling initiatives designed to help consumers and commercial/industrial procurement officials identify and purchase energy-efficient equipment that will save them money and reduce greenhouse gas (GHG) emissions over the life of the product.

For example, the Act and the Regulations require that an EnerGuide label be displayed on major electrical household appliances and room air conditioners. For appliances, the EnerGuide label shows the consumer the estimated annual energy consumption of the product in kilowatt hours and compares it with the most and least efficient models of the same class and size. Labels for room air conditioners indicate the model's energy efficiency ratio and provide a comparative bar scale.

The EnerGuide label is also used voluntarily by manufacturers and suppliers of residential oil and gas furnaces, vented gas fireplaces, central air conditioners and air-to-air heat pumps. In this case, the EnerGuide rating for a specific product (annual fuel utilization efficiency rating for oil and gas furnaces, fireplace efficiency rating for gas fireplaces and seasonal energy efficiency ratio for central air conditioners) is published on the back page of the manufacturer's brochure and includes a bar scale enabling consumers to compare the model with others of the same size and capacity.

The EnerGuide for Industry Program uses the EnerGuide name to encourage the use of more energy-efficient off-the-shelf industrial equipment, including equipment prescribed under Canada's *Energy Efficiency Regulations*. This equipment includes electric motors; dry-type transformers; heating, cooling and ventilation equipment; and certain lighting products. EnerGuide for Industry offers up-to-date product databases, Web-based applications and energy-use information that enable equipment buyers to compare the energy performance of various products and select the most energy-efficient model that meets their needs.

As well, the Regulations are consistent with and build on the ENERGY STAR® initiative in Canada. The internationally recognized ENERGY STAR symbol is a simple way for consumers to identify products that are among the most energy efficient on the market. Products that are prescribed in the Regulations and are also part of the ENERGY STAR initiative must meet levels of energy efficiency starting at 10 percent or more above the minimum performance levels set out in the Regulations in order to qualify for the ENERGY STAR symbol. As higher-performance products penetrate the market, ultimately their efficiencies become candidates for standard levels.

Standards

As a world leader in the use of energy efficiency standards, NRCan is committed to harmonizing federal standards and labelling requirements with those developed in other jurisdictions. Harmonization reduces barriers to trade and sustainable development by improving the flow of energy-efficient products within Canada and around the world, minimizes the regulatory burden on manufacturers, and avoids confusion for consumers.

For instance, the performance requirements in Canada's *Energy Efficiency Regulations* are similar to those in several Canadian provinces that regulate energy-using equipment manufactured and sold within their borders. Although NRCan works closely with provinces to ensure maximum harmonization of standards, in some cases provincial regulations may differ from the federal requirements or may apply to other types of energy-using equipment.

Due to the highly integrated North American market, Canada's energy performance requirements for many products are also similar to those regulated in the United States. As well, Canada's EnerGuide labelling requirements are coordinated with the U.S. EnergyGuide labelling program. Harmonization work is also undertaken through the North American Energy Working Group (NAEWG), established jointly by Canada, the United States and Mexico. During the report period, consultations with the NAEWG were initiated on developing a common North American approach to reducing "stand-by loss" in many electricity-using products.

The Asia-Pacific Economic Cooperation (APEC) organization is another important forum for regional cooperation on harmonization issues. Trade and investment liberalization and facilitation are high on the agenda of the APEC Energy Working Group (EWG). Among other initiatives, the EWG has been endeavouring to harmonize energy efficiency test methods and conformity assessment regimes of Asia-Pacific economies that use energy efficiency standards and labels as part of their environmental or energy programs. During the report period, Canada made a major contribution to maintaining the APEC standards information Web site.

NRCan also supports Canadian representation on committees of the International Organization for Standardization and the International Electrotechnical Commission as well as the national and international policy work of the Standards Council of Canada.

Compliance and Enforcement

The *Energy Efficiency Regulations* outline a number of responsibilities for dealers who import to Canada, or ship from one Canadian province to another, any prescribed energy-using product. NRCan is committed to securing voluntary compliance but can use a range of enforcement measures when necessary.

NRCan emphasizes self-monitoring, reporting, voluntary compliance and collaboration. However, the *Energy Efficiency Act* prescribes specific enforcement measures in cases where dealers violate the law. Enforcement activities include preventing products that do not meet the prescribed energy efficiency standard from entering Canada; preventing the sale or lease of non-compliant products in Canada; and fines. Violators can also be fined under the Administrative Monetary Penalty System of the Canada Border Services Agency (CBSA) for not providing required information on the prescribed product at the time of import; serious violations can be prosecuted.

To monitor compliance with the Regulations, NRCan captures information from two sources: energy efficiency reports and import documents. Section 5 of the *Energy Efficiency Act* requires that dealers provide energy efficiency reports when they first market a new product model. They provide NRCan with such information as the energy performance of each particular model, the name of the testing agency, the size category and other facts, as described in Schedule IV of the Regulations.

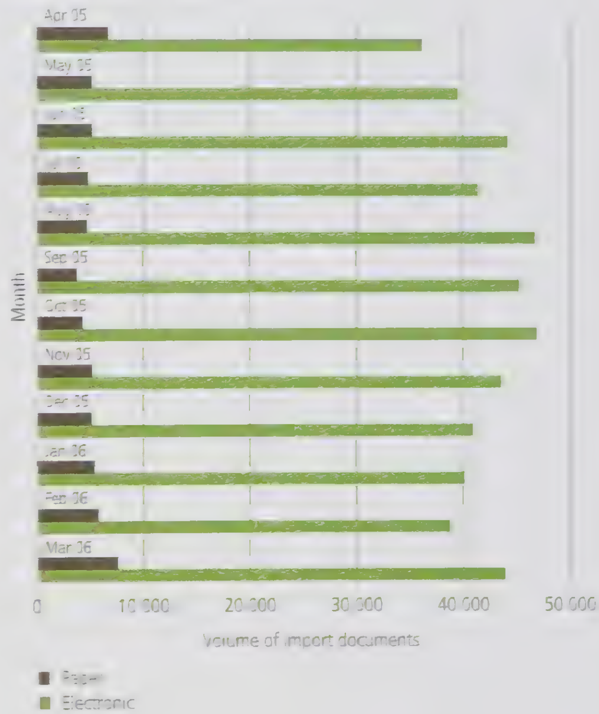
The Regulations require that, when importing a regulated product into Canada, dealers provide to CBSA officers specific product information on customs documents for all shipments (type of product, brand name, model number, name and address of dealer and purpose of import). Customs documents contain much less information than the energy efficiency report, but there is enough to allow NRCan to verify that there is a matching energy efficiency report. NRCan is then in a position to verify that all products entering Canada meet the required energy performance levels and to take action when necessary.

Key 2005–2006 Achievements

- NRCan processed over 570 108 records (records from April 1, 2005, to March 31, 2006) relating to the importation of regulated energy-using products to Canada in 2005–2006. Figure 2-1 illustrates the volume of import documents received in paper form and electronically per month over the 2005–2006 fiscal year.
- Over 95 877 new or revised model numbers were submitted to NRCan for entry into NRCan's equipment database (records from April 1, 2004, to March 31, 2005) from energy efficiency reports received from dealers.

FIGURE 2-1

Volume of Monthly Import Documents



Regulatory Impact to Date per Regulatory Impact Analysis Statement

In preparing amendments to the Regulations, NRCan analyses the impact of the proposed amendment on society, the economy and the environment. This information is made available through the Regulatory Impact Analysis Statement, which is annexed to the Regulations and published in the *Canada Gazette, Part II*.

As a result of Canada's minimum energy performance standards, it is estimated that an aggregate annual emissions reduction of 25.6 megatonnes will be achieved by 2010 (see Table 2-1). This is equivalent to taking 4 million cars off the road. The net benefit to consumers from just the latest amendment prescribing new standards for clothes washers, water heaters, chillers and exit signs is estimated to be $47 million by 2010. These benefits will continue to grow during the lifetime of the machines, which in some cases is 25 years.

TABLE 2-1

Estimated Impact of *Energy Efficiency Regulations*, 2010 and 2020 (aggregate annual savings)

Product (amendment number in brackets)	Energy savings (petajoules)		CO_2 reductions (megatonnes)	
	2010	**2020**	**2010**	**2020**
Residential appliances	117.20	133.84	13.26	15.60
Lamps – fluorescent/incandescent	11.60	13.40	7.55	9.80
Motors	16.30	17.70	2.03	2.14
Commercial HVAC	6.40	7.50	0.43	0.57
Refrigerators (5)	4.92	10.96	0.49 *	1.10 *
Ballast/room A/C, PAR lamps (6)	3.96	9.44	0.39 *	0.94 *
Clothes washers, domestic hot water, exit signs, chillers (8)	16.20	42.67	1.29	3.61
A/C, commercial refrigeration (draft 9)	1.57	5.35	0.16	0.53
Total	**178.15**	**240.86**	**25.60**	**34.29**

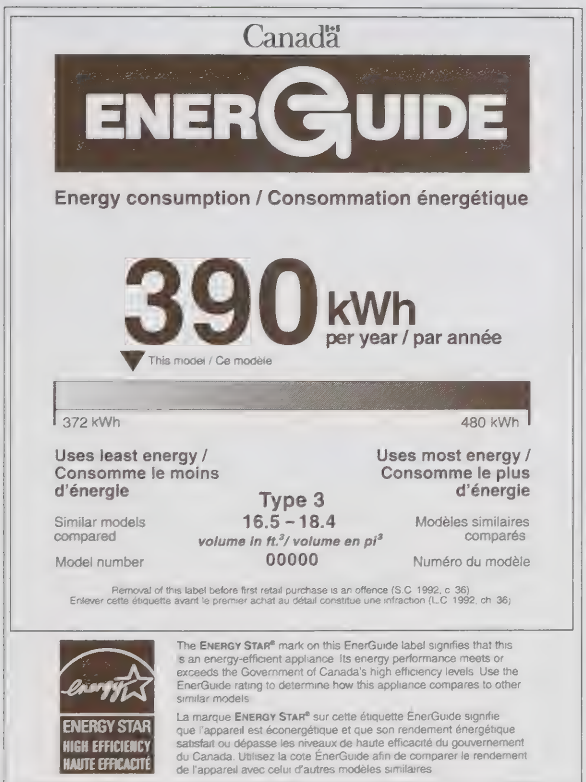
*Values different from Regulatory Impact Analysis Statement due to emission factor change (using 99.3)

Labelling and Promotion

Since 1978, the EnerGuide label (see Figure 2-2) has given Canadians an opportunity to compare the energy consumption of one appliance with that of another. In 1995, with the introduction of the *Energy Efficiency Regulations*, placing an EnerGuide label on major electrical household appliances and room air conditioners became mandatory. Placing a label on a product before the first retail sale shows consumers how much energy a product uses, enabling them to consider the most energy-efficient purchase.

FIGURE 2-2

EnerGuide Label



A voluntary EnerGuide rating program was established in 1997 and included gas furnaces, central air conditioners, heat pumps and oil furnaces. In the fall of 2003, coincident with the requirement in Canada's *Energy Efficiency Regulations* to test, verify and report on fireplace efficiency, gas fireplaces were added to the EnerGuide rating program, and manufacturers were asked to integrate EnerGuide fireplace efficiency ratings in their brochures. Since these products are typically purchased from a product brochure or catalogue, prescribing a label on the product would not be useful. Manufacturers are encouraged to include an EnerGuide rating in product brochures or catalogues, so consumers can compare the efficiency of the product when they are in the buying process. All major distributors of such products for sale in Canada report the verified energy performance rating of their products, as tested to the standards referenced in the *Energy Efficiency Regulations*. The verified energy performance rating submitted corresponds to the EnerGuide rating published in the brochures or catalogue. To date, manufacturers representing 85 percent of the products in the marketplace participate in the EnerGuide rating program and publish the ratings in their brochures. In addition, program participants must provide shipment data and aggregate energy efficiency information to track the progress of the program and identify marketplace improvements that could result from labelling.

EnerGuide directories with energy ratings for major appliances and room air conditioners are published each year and distributed to consumers, retailers and appliance salespeople. In fulfilling requests for information, electric utilities and provincial governments also distribute the directories. On-line directories published on the Office of Energy Efficiency Web site for all appliances and heating and cooling equipment are available and updated monthly.

Regularly conducted polls indicate that more than 50 percent of Canadians surveyed are aware of the EnerGuide label.

In 2001, responding to Canadians' desire for a labelling system designed to identify the best performers, Canada officially introduced ENERGY STAR, the international symbol for energy efficiency (see Figure 2-3). An agreement was signed with the U.S. Environmental Protection Agency and the U.S. Department of Energy. The Office of Energy Efficiency is the official custodian of the program for Canada. Canada became the fifth country to join the ENERGY STAR program, along with Australia, New Zealand, Japan and Taiwan. The European Union has adopted ENERGY STAR for office equipment.

FIGURE 2-3

ENERGY STAR® Label

ENERGY STAR establishes high efficiency criteria and levels for selected products for the residential and commercial sectors. Product categories are selected for the technical potential for high efficiency. This is a voluntary program. However, organizations must demonstrate that products meet the admissibility criteria and high performance levels endorsed by ENERGY STAR. For appliances and heating and cooling products, the criteria are based on the same test standards as those applied under the *Energy Efficiency Regulations* and are used to qualify products for the ENERGY STAR symbol.

Canada promotes specific product categories for which levels and criteria can be harmonized with those of the United States, including the following:

- Major appliances
- Heating, cooling and ventilation
- Consumer electronics
- Office equipment
- Windows and doors (Canadian levels)
- Selected lighting products (currently not fixtures)
- Selected commercial equipment

Canada has also integrated ENERGY STAR with the EnerGuide label for major appliances and room air conditioners to help consumers identify the best-performing products. While the EnerGuide label shows how much energy a product uses under normal conditions in one year, the ENERGY STAR symbol on the label identifies the most energy-efficient product. Now that industry-accepted standards of high efficiency have been established, ENERGY STAR has become the criterion to meet for incentive and rebate programs.

As part of the *Government of Canada Action Plan 2000 on Climate Change*, pilot projects were implemented in partnership with seven Canadian gas utilities and a non-government organization to address three major barriers to higher efficiency: awareness, accessibility to high-efficiency products and acceptance. From 2001 to March 2006, Canada cost-shared over 75 000 incentives to Canadian consumers for the purchase of high-efficiency, ENERGY STAR qualified gas-fired furnaces and boilers. The number of incentive-based installations represents approximately one quarter of the total gas furnace/boiler installations across Canada. The partners' contribution amounted to $15 million, and Canada's, $9.8 million. With NRCan's involvement, several utilities doubled the number of incentives and/or loan recipients that they would otherwise have disbursed without government participation or under their previous programs. The organizations also coordinated the delivery of coupons by manufacturers to complement the incentive. Canada's participation in this initiative also helped to increase the market penetration of high efficiency gas-fired furnaces and boilers and to widen the net of higher efficiency products to cover markets that traditionally support mid-standard-efficiency products.

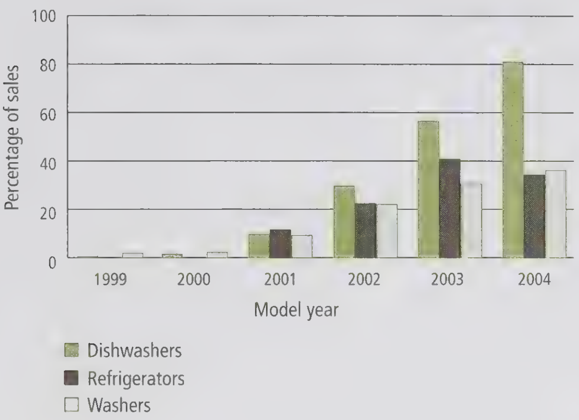
ENERGY STAR was also used as the basis for sales tax rebates in British Columbia for heating and cooling equipment, and in Saskatchewan for the purchase of qualifying appliances (refrigerators, dishwashers, clothes washers and freezers) and furnaces and boilers. Organizations across Canada have used ENERGY STAR as a campaign driver to promote replacement with, or purchase of, higher-efficiency products.

Continuous efforts to promote ENERGY STAR qualified appliances have paid off. Industry figures for 2004 show an increase in market penetration from almost nil in 2000 to 34 percent for refrigerators and 81 percent for dishwashers (see Figure 2-4). The increase in market penetration indicates growing acceptance of ENERGY STAR as the brand for high efficiency and the willingness of manufacturers to raise product offerings to qualifying levels. In this regard, ENERGY STAR specifications and levels are periodically updated as product saturation is reached to encourage industry to strive for more

efficient products and thus maintain the relevance and credibility of the brand. Subsequent increases in qualifying levels for ENERGY STAR qualified products such as central air conditioners and heat pumps came into effect in 2006, and more stringent levels for clothes washers and dishwashers will come into effect in 2007.

FIGURE 2-4

ENERGY STAR Qualified Appliances as a Percentage of Total Category Sales in Canada, 1999 to 2004



ENERGY STAR is also well known in the commercial sector, with criteria for products ranging from office equipment to traffic signals. NRCan supports demonstration projects to validate the savings and other benefits of some of these products and address barriers to their widespread acceptance. One example is the department's support for the accelerated replacement and promotion of light-emitting diode (LED) exit signs for retrofit applications in Alberta. Exit signs operate around the clock; and for high-rise buildings, with a minimum of four signs per floor at approximately 25 watts per sign, these products represent a constant electrical draw and, therefore, an energy savings opportunity for building owners. The project objective was to target apartment building owners, stimulate demand for LED exit signs and increase awareness of the benefits of early replacement of standard incandescent exit signs with more efficient LED units consuming 5 watts per sign. The project also included recycling of the replaced units. The program influenced the conversion of 7311 incandescent exit signs with LED exit signs, yielding approximately 1.6 gigawatt hours per year of electricity savings, and 570 tonnes of carbon dioxide reductions. For all new installations, Canada's *Energy Efficiency Regulations* now require that exit signs meet the ENERGY STAR level of 5 watts per face.

Canada continues to promote ENERGY STAR guidelines for procurement officials. It has updated an interactive cost calculator that compares energy cost savings and GHG emissions reductions associated with the purchase of ENERGY STAR qualified products. A number of workshops were held across Canada, from Newfoundland and Labrador to Nunavut and the Northwest Territories, to make governments, institutions and city officials aware of the ENERGY STAR criteria and procurement tools. Canada is also working with housing agencies to help them identify energy savings in their properties and to specify ENERGY STAR qualified products at the time of replacement or retirement.

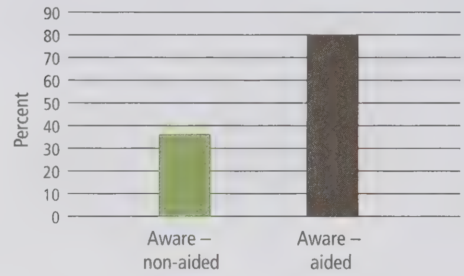
Canada continues to expand the types of products included in its ENERGY STAR agreement. For example, Canada recently included vending machines, commercial refrigeration, compact fluorescent lamps and commercial clothes washers in its exchange of letters with the United States government.

Key 2005–2006 Achievements

- Canada held its third annual meeting of ENERGY STAR participants and awarded plaques of recognition to nine forward-looking organizations, recognizing their commitment to producing, selling and promoting ENERGY STAR qualified products. Over 30 manufacturers and retailers were recruited as new ENERGY STAR participants, bringing the number to over 250 participants.
- Surveys on the awareness of ENERGY STAR have shown an increase in unaided awareness and understanding of the symbol. A survey of 2000 Canadians revealed that unaided awareness was 36 percent in 2005. Aided awareness of ENERGY STAR has reached 80 percent (refer to Figure 2-5). Recognition of ENERGY STAR has shifted from seeing the symbol on computer equipment to seeing it more often on major appliances.
- Market information submitted as part of the EnerGuide rating program for gas fireplaces shows that shipment of units with higher efficiency ratings has increased. In 2005, 85 percent of the units shipped ranged in efficiency from 50 to 69.9 percent. In 2004, 76 percent of the units shipped were in this efficiency range. In 2003, the percentage stood at 31 percent.

FIGURE 2-5

ENERGY STAR Awareness Levels in Canada, 2005



Chapter 3: Housing

Energy Use and Greenhouse Gas Emissions

The residential sector includes four major types of dwellings: single detached, single attached, apartments and mobile homes. Energy is used in dwellings for space heating and cooling, heating water, and operating appliances, electronic equipment and lights. This sector accounts for 16.6 percent (1421 petajoules) of secondary energy use and 15.2 percent (77 megatonnes) of greenhouse gas (GHG) emissions.

Most dwellings in Canada are single detached houses, followed by apartments, single attached dwellings and mobile homes (see Figure 3-1). Because single detached and attached houses predominate, most Natural Resources Canada (NRCan) residential building programs focus on these types of dwellings.

Space and water heating make up 81.6 percent of residential energy use, followed by the shares devoted to operating appliances, lighting and space cooling (see Figure 3-2).

Between 1990 and 2004, residential energy use increased by 10.2 percent, or 131 petajoules (from 1289 to 1421 petajoules). From 1990 to 2004, GHG emissions from the residential sector increased by 10.3 percent. GHG intensity changed little because fuel switching towards less GHG-intensive fuels offset an increase in the GHG intensity of electricity production over the period.

Four main factors tended to influence residential energy use – activity, weather, structure and energy efficiency:

- activity – the increase in the number of households and the size of dwellings (the principal measures of residential activity) increased energy use by 25.7 percent (331 petajoules).
- weather – the difference in temperature in 2004 compared to 1990 resulted in a 2.0 percent (26 petajoules) increase in energy use in 2004.
- structure – the percentage shares of energy end-uses changed over the period such that they increased energy use by 3.6 percent (46 petajoules).
- energy efficiency – improvements in energy efficiency decreased energy use by 21.0 percent (271 petajoules).

Growth in residential energy use was driven in large part by growth in activity. This increase was partially offset by significant improvements in energy efficiency. Structural changes had a minor impact on residential energy use.

The change in overall residential energy use from the years 1990 to 2004, as well as the estimated energy savings due to energy efficiency, is shown in Figure 3-3. Figures 3-4 and 3-5 show how energy consumption differs for houses built to different standards and in different periods, reflecting improvements in building construction. Figure 3-6 shows how average energy consumption of new appliances has improved by comparing 1990 and 2004 models.

FIGURE 3-1

Canadian Households by Type of Dwelling, 2004

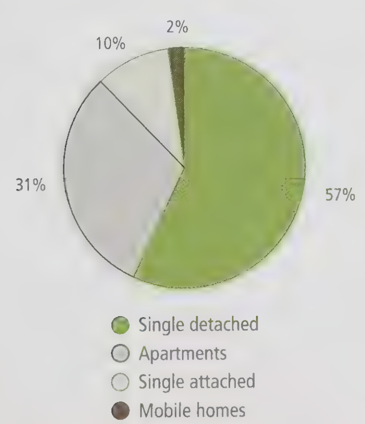
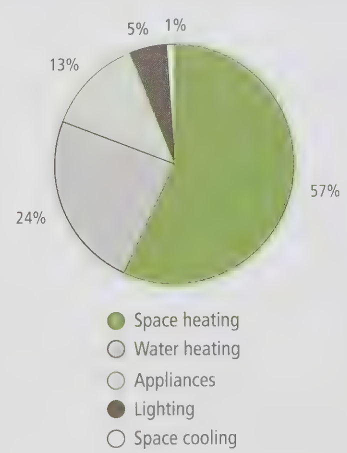


FIGURE 3-2

Residential Energy Use by Purpose, 2004



NRCan delivers initiatives to increase energy efficiency in the following residential sub-sectors:

- new houses
- existing houses
- residential equipment (refer to Chapter 2)

FIGURE 3-3

Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004

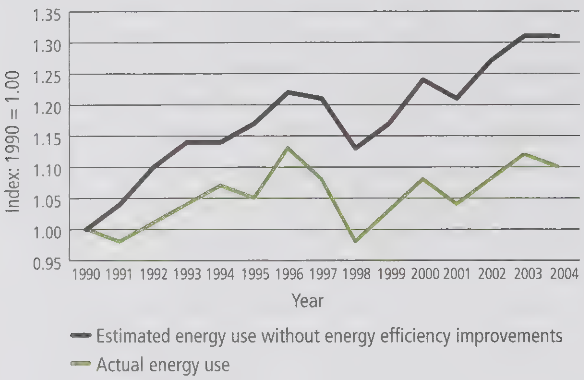
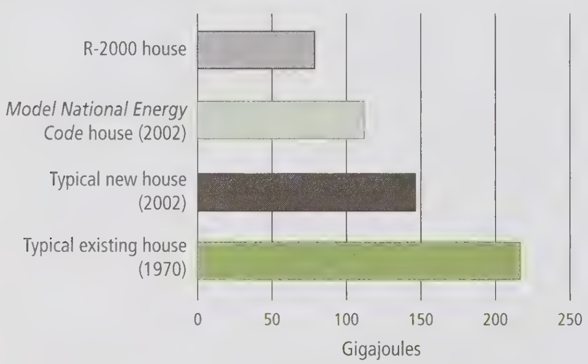


FIGURE 3-4

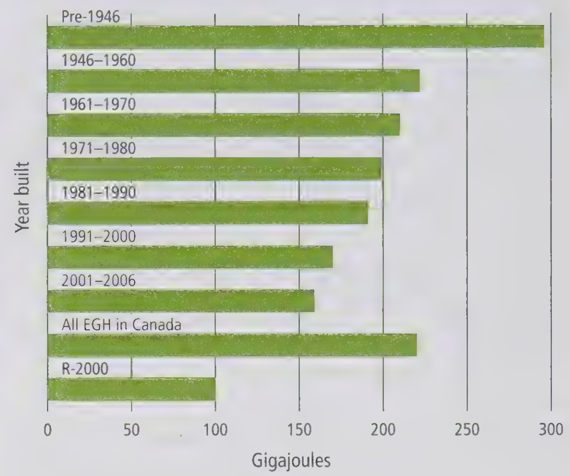
Annual Heating Consumption for Houses* Constructed to Different Standards



*198-m² one-storey, single detached house heated with natural gas, Ottawa, Ontario

FIGURE 3-5

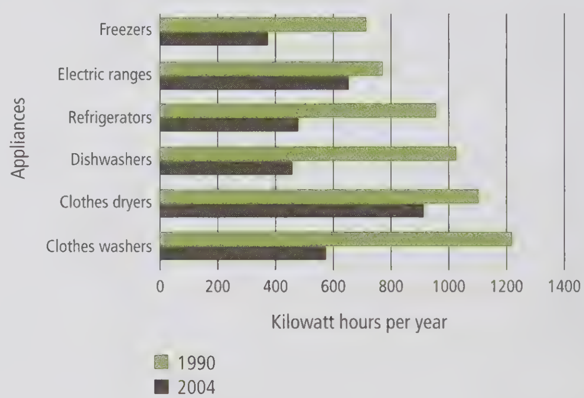
Average Energy Consumption per Household,* Pre-1946 to 2001–2006 Construction



*From R-2000 and EnerGuide for Houses (EGH) programs

FIGURE 3-6

Average Energy Consumption of New Appliances, 1990 and 2004 Models



New Houses: R-2000 Standard and EnerGuide for (New) Houses

Objective: To increase market adoption of energy-efficient new houses by promoting changes in construction practices and by labelling houses for energy performance.

The R-2000 Standard is a voluntary technical performance standard that encourages Canadian builders to build, and Canadian consumers to purchase, houses that are more energy efficient and environmentally responsible than is required by current Canadian building codes. NRCan trains and licenses R-2000 homebuilders and other professionals in R-2000 Standard construction techniques and practices, and it provides third-party quality assurance by testing and certifying R-2000 homes.

EnerGuide for (New) Houses is an energy-performance rating and labelling scheme designed to encourage the industry to build, and consumers to purchase, more energy-efficient houses. The EnerGuide for Houses scheme is based on the R-2000 Standard and training, and it targets large-volume, mass-market builders.

Key 2005–2006 Achievements

- Sixty tract builders and 75 new professionals received training in revisions to EnerGuide for New Houses and R-2000 Standard. Over 3000 builders and industry professionals were trained. Over 172 000 publications about the R-2000 Standard, ENERGY STAR® and EnerGuide for New Houses were distributed.
- ENERGY STAR technical specifications were finalized in cooperation with industry and other stakeholders. Methodology for multi-unit application of the R-2000 Standard was completed.
- In 2005–2006, 480 homes were certified R-2000, and 8700 homes across Canada were built under provincial and territorial initiatives that use the R-2000 Standard and training – for example, Built Green Alberta, Novo climat in Quebec and the Yukon Green Home.

For more information:
oee.nrcan.gc.ca/r-2000/english

R-2000 is an official mark of Natural Resources Canada.

FIGURE 3-7

Number of Eligible R-2000 Housing Starts, 1990 to 2005

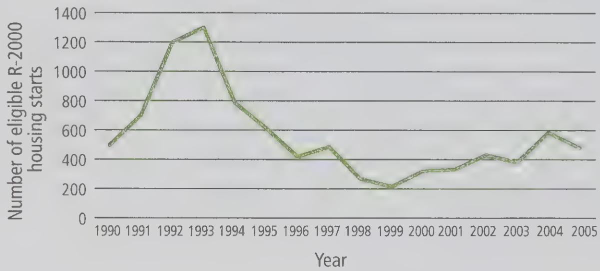
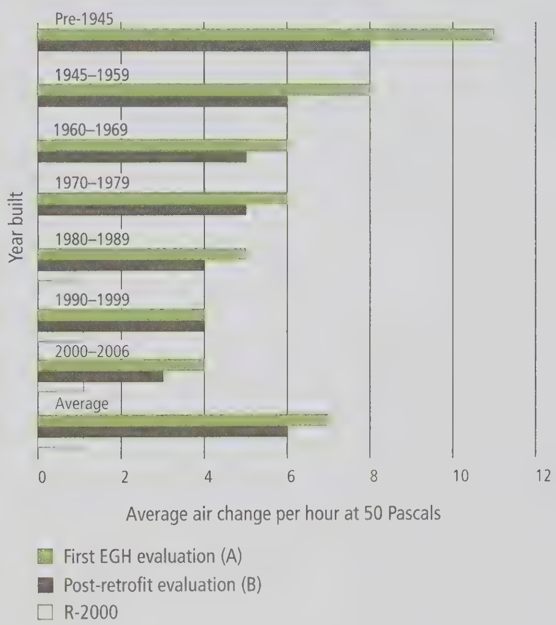


FIGURE 3-8

National Trends in Air Leakage in Houses, Pre-1945 to 2000–2006 Construction



New Houses: Housing Energy Technology Program

Objective: To accelerate the development and market adoption of energy-efficient housing technologies.

Working in partnership with associations, government and industry, the CANMET Energy Technology Centre (CETC) manages this program to develop and deploy highly specialized solutions to help achieve cost-effective reductions in the energy consumption and GHG emissions of Canadian houses. Progress to date includes the identification, accelerated development and broader deployment of a number of promising technologies, such as advanced integrated mechanical systems (now trademarked ēKOCOMFORT™) and electronically commutated motors.

In whole-house design, development and technical support of the R-2000 Standard has led to extensive technology development and deployment throughout the housing sector. Through its associated Building Energy Simulation Program, CETC's software tools are widely used to assess energy use in a home. CETC also develops more energy-efficient frames for windows and is a lead managing agency for the Canadian Centre for Housing Technology (CCHT), an advanced testing facility for assessing whole-house impacts of emerging technologies.

Key 2005–2006 Achievements

- ēKOCOMFORT™ integrated mechanical systems were adapted for use in the Drake Landing Solar Community to make use of the lower-temperature heat delivered from its innovative seasonal storage residential district system. The project is bringing together whole-house design expertise from the housing program, R-2000 construction practices, and technologies like its ēKOCOMFORT™ systems.
- Through accelerated research, development and commercialization with industry partners, a new zoned comfort system has been fast-tracked into the marketplace. This system delivers heating and cooling directly to spaces when and as required, and it is already attracting interest from builders and utilities.
- Innovative lighting research on compact fluorescent lights was undertaken at the CCHT, demonstrating the energy-saving potential of this technology and its impacts on whole-house energy consumption.

For more information:
sbc.nrcan.gc.ca/housing/housing_e.asp

ēKOCOMFORT is a Trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

New Houses: Super E™ House Program

Objective: To build capacity for exporting energy-efficient, durable and environmentally friendly Canadian housing technology to foreign markets.

The Super E House Program is a technology transfer initiative that has successfully increased the demand for Canadian energy-efficient housing technologies and building practices in international markets. Canadian companies have adapted their products and services to meeting increasingly higher environmental standards of energy efficiency demanded by foreign markets. The program adapts world-leading Canadian energy efficiency standards to foreign markets and identifies appropriate technologies for them to create unique market opportunities for Canadian housing technology companies. Launched in 1998, the Super E House Program has facilitated partnerships between Canadian builders and their foreign counterparts to increase market penetration of Canadian energy-efficient technologies internationally.

The Canada Mortgage and Housing Corporation (CMHC), the Canadian Forest Service and CETC financially support the Super E U.K. program. The Super E Japanese program is financially supported by CETC with in-kind support from CMHC. In both cases, there is strong support from Foreign Affairs and International Trade Canada. Industry members also contribute to the success of the program through in-kind and financial contributions (member fees).

CETC has facilitated and provided expert advice to Canadian housing exporters to redesign wall systems to incorporate high levels of insulation and airtightness for markets unfamiliar with energy-efficient wood frame construction; to redesign wall systems to reduce cooling loads in hot humid climates; to establish optimal specifications for high performance windows for both heating and cooling climates; and to develop strategies to incorporate innovative mechanical heat recovery ventilation systems into the design. In-house tools such as HOT2000™ have been used to optimize and position Super E packages as an attractive energy-efficient option for foreign markets.

The Super E House Program is attracting demand and generating real economic benefits for Canada – at least $35 million to date. There are 85 Canadian and international companies involved in the program and over 345 houses have been built or are under construction. Future orders are in the range of 1500 units over the next four years, amounting to well over $150 million in potential sales. Super E is active with projects in Japan, the United Kingdom, Ireland, China and Iceland. Interest has been expressed by French, Spanish, Korean and Taiwanese concerns.

Key 2005–2006 Achievements

- Delivery of the first 100 units under a five-year contract for 1400 Super E units with Berekely homes in the U.K. This represents $100 million in revenue to the Canadian supplier.
- Nine new Canadian members and 11 new foreign members joined the Super E consortium, which now has 39 Canadian members partnered with 46 overseas companies. In 2005, 138 houses were registered as completed or under construction, raising the total number of registered units from 207 at the end of 2004 to 345 at the end of 2005 – an increase of well over 50 percent. This included six high profile openings (three in the United Kingdom, one in Japan, one in China and one in Iceland).
- Demand increased for Super E from other countries such as China, Korea, France, Iceland and Spain. The first Super E project in Iceland was completed, a demonstration Super E initiative was launched in Shanghai, China, and four Chinese developers joined the Super E consortium.

For more information:
www.super-e.com/html/canada/English/about-e.html

Super E is an official mark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

Existing Houses: EnerGuide for Houses and Retrofit Incentives

Objective: To encourage Canadians to improve the energy efficiency of their homes.

EnerGuide for Houses (EGH) provided Canadian homeowners with personalized expert advice on how to best improve the energy performance of their houses, especially when undertaking renovation and maintenance projects. Under EGH, a retrofit incentive was officially launched in October 2003. Under this incentive, homeowners qualified for a non-taxable grant representing 10 to 20 percent of their retrofit expenditures. The grant was based on the differential improvement in the house's energy rating, as measured by a pre- and post-renovation EGH energy evaluation.

The EGH Retrofit Incentive program has been discontinued as of May 12, 2006. Property owners who had a pre-retrofit evaluation performed prior to this date can have a post-retrofit evaluation and still qualify for a grant until March 31, 2007.

Key 2005–2006 Achievements

- One national promotional campaign was held, reaching 5.7 million Canadians, and many provincial campaigns took place through partnerships with local utilities.
- Procedures for the application of EGH to multi-unit housing were completed.
- Over 79 000 houses were evaluated and labelled and more than 31 800 homes completed their energy-related retrofits. Over 30 000 grants totalling $24 million were awarded, reducing energy consumption by an average of 28 percent in post-retrofit homes and GHGs by 4.1 tonnes per house per year. Achieved cumulative GHG reductions of 0.7 megatonnes per year as of March 31, 2006; the target for March 2007 is 0.8 megatonnes per year.

FIGURE 3-9

Evaluations Under EnerGuide for Houses, 1998 to 2005

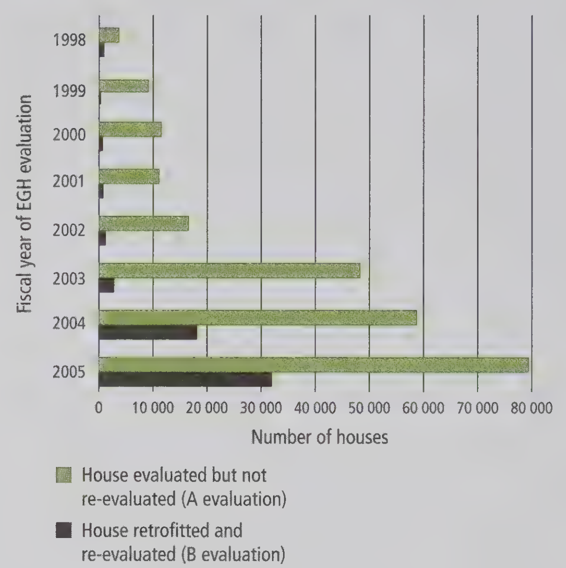
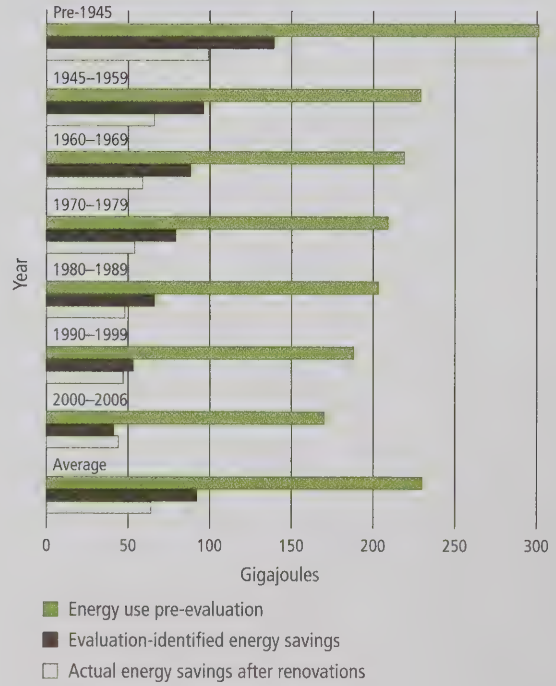


FIGURE 3-10

Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2006



Chapter 4: Buildings

Energy Use and Greenhouse Gas Emissions

The commercial/institutional sector includes activity related to trade, finance, real estate, public administration, education, and commercial services, including tourism. This sector uses energy mainly for space and water heating, space cooling, lighting, motive power for services such as pumping and ventilation in buildings, and street lighting.

In 2004, the total commercial/institutional sector accounted for 13.7 percent (1171 petajoules) of secondary energy use and 13.4 percent (67.9 megatonnes) of greenhouse gas (GHG) emissions.

To highlight energy use in commercial/institutional activities, the following analysis excludes energy use for street lighting. The commercial/institutional sector comprises many activity types (see Figure 4-1). Offices account for one third of commercial/institutional sector energy demand. Educational services, health care and social assistance, retail trade, and accommodation and food services account for another 49 percent of that demand. Natural Resources Canada's (NRCan's) initiatives address all of these major energy-using activity types.

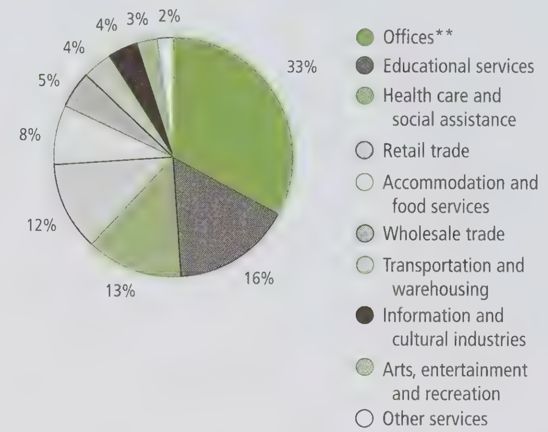
Energy is used for six purposes in commercial/institutional activities. The largest of these is space heating, which accounts for more than half of energy use in this sector (see Figure 4-2). Each of the remaining five uses of energy accounts for between 6 and 14 percent of energy demand in this sector.

Between 1990 and 2004, commercial/institutional energy use, excluding street lighting, increased by 35.6 percent, or 305 petajoules (from 858 to 1163 petajoules). However, GHG emissions from the sector rose by 42.0 percent in the same period. Emissions increased more quickly than energy use due to the increased use of energy sources with a higher GHG content.

During 1990–2004, a steady increase in activity largely contributed to increased energy use. To a lesser degree, the service level for auxiliary equipment, structure (the mix of building types) and weather also each played a role. However, energy efficiency slowed this rate of increase. Specifically, the energy use changes attributed to each of these factors are

FIGURE 4-1

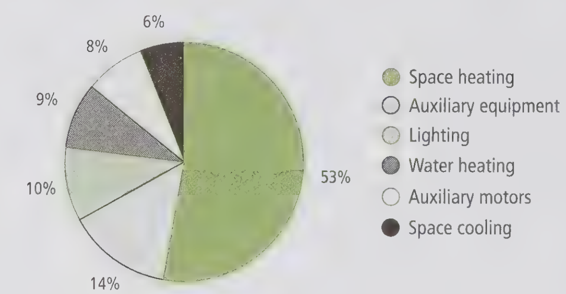
Commercial/Institutional Energy Use by Activity Type,* 2004



*Excludes street lighting
**"Offices" includes activities related to finance and insurance; real estate and rental and leasing; professional, scientific and technical services; and public administration

FIGURE 4-2

Commercial/Institutional Energy Use by Purpose,* 2004



*Excludes street lighting

- activity – a 24.4 percent increase in floor space resulted in a 219-petajoule increase in energy use.
- weather – the difference in temperature in 2004 compared to 1990 resulted in a 1.3 percent increase in energy use (11 petajoules).
- structure – a shift in activity resulted in a 0.4 percent increase in energy use (3 petajoules).
- service level – a higher service level for end-users resulted in an 8.8 percent increase in energy use (75 petajoules).
- energy efficiency – a 0.4 percent improvement in energy efficiency resulted in a decrease of 3 petajoules. See the text box, "Possible Underestimation of the Energy Efficiency Effect," for additional explanation.

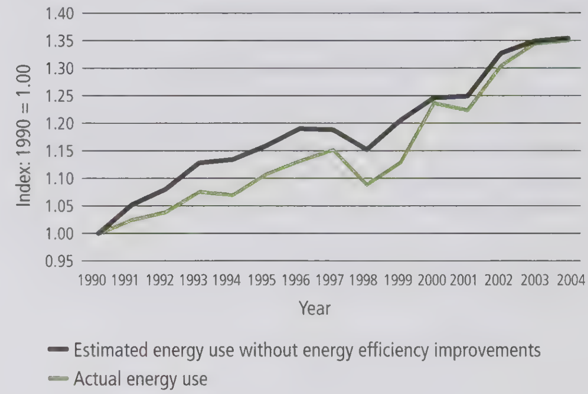
The change in energy use during 1990–2004, as well as the estimated energy savings due to energy efficiency, is shown in Figure 4-3.

Possible Underestimation of the Energy Efficiency Effect

Between 1999 and 2004, energy use in the commercial/institutional sector increased by 20 percent, whereas floor space (activity driver) increased much more slowly, about 8 percent. This rapid growth in energy use since 1999, mostly due to heavy fuel oil (188 percent rise), light fuel oil and kerosene (95 percent rise), has led to sharp decreases in the energy efficiency effect since 1999. Statistics Canada has been unable to ascertain the reason (or reasons) for these spikes in petroleum use, particularly heavy fuel oil. Some of the change may be due to legitimate fuel switching away from natural gas, which sharply increased in price in 2000, to light fuel oil. However, there is some evidence that fuel marketers (included in the commercial/institutional sector) are buying petroleum products from refineries and then re-selling the fuel to other sectors (e.g. industrial, transportation). As a result, some heavy fuel oil, light fuel oil and kerosene may be erroneously attributed to the commercial/institutional sector. There is inadequate information to determine and to improve the quality of the reported commercial/institutional data at this time.

FIGURE 4-3

Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004



NRCan delivers initiatives to increase energy efficiency in the following sub-sectors of the commercial/institutional sector:

- new buildings
- existing buildings
- equipment (refer also to Chapter 2)
- communities

New Buildings: Commercial Building Incentive Program

Objective: To improve the energy efficiency of new commercial, institutional and multi-unit residential buildings.

The Commercial Building Incentive Program (CBIP) provides financial incentives to builders and developers who incorporate energy-efficient features into the design and construction of new commercial, institutional and multi-unit residential buildings. To qualify for the incentive, buildings must be at least 25 percent more energy efficient than similar buildings constructed to the *Model National Energy Code for Buildings* (MNECB). However, results indicate that CBIP buildings are on average 36 percent better than similar buildings constructed to the MNECB. The program is delivered by the Government of Canada and co-marketed by a number of provincial/territorial utilities, provincial/territorial energy efficiency and climate change agencies, and building professional organizations.

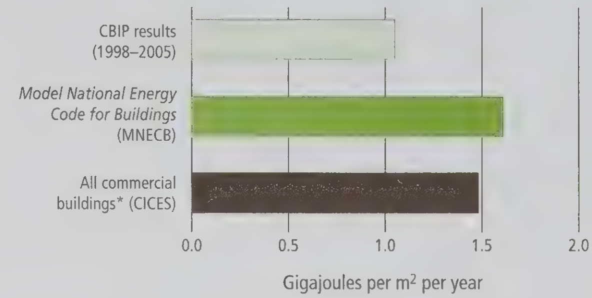
Key 2005–2006 Achievements

- Incentives were given to 207 projects, representing 4.1 percent of building starts and 15 percent of construction floor space in 2005–2006.
- CBIP cooperated with 22 organizations during 2005–2006, launching new collaborative ventures with the Toronto Waterfront Revitalization Corporation, the Toronto Community Housing Corporation and the Canadian Urban Institute.
- Over 900 new users registered to use CBIP's simulation software in 2005–2006, bringing the total number of users to over 5000.

For more information:
oee.nrcan.gc.ca/newbuildings

FIGURE 4-4

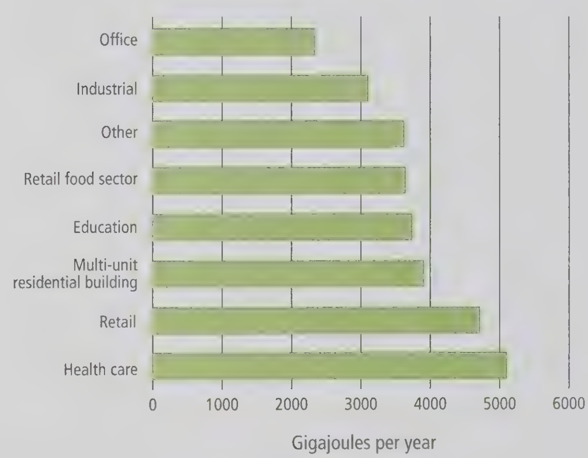
Energy Use in Commercial Buildings, 2005



* Source: Commerical and Institutional Consumption of Energy Survey (CICES), December 2005, NRCan data using CBIP building mix

FIGURE 4-5

Estimated Average Energy Savings by Type of Building Under the Commercial Building Incentive Program, 2005



New Buildings: Industrial Building Incentive Program

Objective: To improve the energy efficiency of new industrial buildings.

The Industrial Building Incentive Program (IBIP), a demonstration program, extends the precepts of CBIP to the industrial sector. IBIP offers an incentive to companies building new energy-efficient industrial facilities to offset the additional costs involved in initial attempts to produce energy-efficient designs and achieve building/process integration. The design is assessed against a reference generated from the MNECB.

Key 2005–2006 Achievements

- Six contribution agreements were signed, bringing to 26 the number of projects supported since the launch of the program in 2002.
- Five case studies were prepared, a new IBIP Web site was completed, and a new technical guide was issued.

For more information:
oee.nrcan.gc.ca/newbuildings

New Buildings: Green Buildings Program

Objective: To reduce energy use, resource consumption and emissions from commercial buildings through design, construction and retrofitting while increasing cost-effectiveness.

The program plays a significant role in establishing goals for energy efficiency and sustainability in commercial buildings through a variety of key activities. Through its C-2000 Program for Advanced Commercial Buildings – which was a small demonstration program for high-performance buildings – CANMET Energy Technology Centre (CETC) worked with industry to demonstrate buildings that reduce energy consumption by 50 percent and water consumption by 40 percent. The program continues to provide the necessary tools, guidelines and techniques through its integrated design process, helping industry and associations to develop optimized, energy-efficient green buildings and green building programs.

The program also develops guidelines, provides technical support and develops downloadable simulation software tools to support other NRCan programs such as CBIP.

NRCan launched the Green Building Challenge (GBC) in 1996 (now managed by a third party) and organized "Sustainable Building" conferences to showcase the results and best practices of the competing energy-efficient buildings. GBC brings together more than 20 countries focused on the development and testing of an internationally accepted system for assessing the environmental performance of buildings. The NRCan-developed electronic GBTool™ is used in the assessments.

Key 2005–2006 Achievements

- NRCan experts continue to provide technical support to the new 600 000-square-foot downtown Winnipeg office for Manitoba Hydro. The $188-million project, due for completion in 2007, is the largest and final participant in the C-2000 Program for Advanced Commercial Buildings. Designed by the C-2000 Integrated Design Process, it focuses on providing the healthiest office space, world-class energy efficiency, and signature architecture and urban design, while staying within market-based costs.
- NRCan successfully proposed to the Canadian Commission on Building and Fire Codes that the MNECB 1997 be updated. NRCan was tasked by the commission to lead a feasibility study for the code update. To this end, NRCan created a national consortium of provincial and federal organizations that are either actively involved in or initiating the development of energy efficiency measures for regulatory and program purposes.

- NRCan spearheaded research to develop a revolutionary façade system that integrates photovoltaic panels. This Building Integrated PhotoVoltaics system was used in the new Public Works and Government Services Canada Greystone office building in Yellowknife, providing 33.5 kilowatts of electricity to this 70 000-square-foot building that opened in October 2005.

For more information:
sbc.nrcan.gc.ca/buildings/buildings_e.asp

GBTool is a Trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

Existing Buildings: EnerGuide for Existing Buildings

Objective: To encourage commercial businesses and public institutions to become more energy efficient and reduce GHG emissions that contribute to climate change.

EnerGuide for Existing Buildings (EEB), formerly the Energy Innovators Initiative, helps commercial organizations and public institutions explore energy efficiency options and strategies, offering them access to tools and financial assistance to help reduce energy costs and improve competitiveness. Members join EEB by sending a letter to the Minister of Natural Resources from senior management stating their commitment to energy efficiency. Currently, over 2800 commercial, institutional and multi-unit residential organizations across Canada are members.

After joining EEB, members can apply for Energy Retrofit Assistance funding for retrofit planning activities and retrofit implementation projects in existing commercial/institutional buildings.

Key 2005–2006 Achievements

- Recruited more than 500 organizations as members, an increase of about 2 percent of floor space in targeted sectors.
- Twenty-one partnerships were established through contribution agreements with member-based associations and stakeholders.
- EEB funded 140 energy retrofit implementation projects (see Table 4-1) and more than 215 retrofit planning activities in commercial businesses, public institutions and multi-unit residential buildings.

For more information:
oee.nrcan.gc.ca/existingbuildings

TABLE 4-1

EnerGuide for Existing Buildings – Incentive Retrofit Projects, 1998 to 2005

Fiscal year	Number of retrofit projects signed	Energy cost savings (millions of dollars)	Eligible client investment (millions of dollars)	Federal incentive (millions of dollars)
1998	12	$5.70	$54.70	$2.60
1999	35	$16.80	$137.70	$5.50
2000	4	$5.40	$8.70	$0.60
2001	30	$10.60	$58.20	$3.74
2002	59	$19.40	$139.60	$8.40
2003	70	$20.90	$132.60	$8.80
2004	169	$36.70	$220.00	$16.90
2005	140	$23.00	$138.48	$12.06
Total	**519**	**$138.50**	**$889.98**	**$58.66**

Equipment: Refrigeration Action Program for Buildings

Objective: To support the development and the adoption of innovative refrigeration technologies that reduce energy consumption, synthetic refrigerant use and GHG emissions in commercial and institutional buildings.

The Refrigeration Action Program for Buildings (RAPB) was launched in 2003. It focuses on the deployment of innovative refrigeration technologies integrated with a building's heating, ventilating and air-conditioning (HVAC) systems in order to drastically reduce refrigerant losses, recover and upgrade the heat rejected by the refrigeration system, and adapt the system operation to the Canadian climate. To meet its objective, the RAPB performs capacity-building, demonstration, information and training activities in partnership with key stakeholders, for Canadian supermarkets, ice rinks and curling rinks. The RAPB also undertakes research and development activities on refrigeration technological solutions.

Key 2005–2006 Achievements

- Launched and is successfully operating a demonstration project involving innovative integrated HVAC and refrigeration technologies at an existing Loblaws supermarket in Ottawa, Ontario. CETC–Varennes provided technical support for the design and installation phases of the project and is carrying out performance analysis of the system.
- Invited to sit on the Vancouver Olympic Committee to provide expertise for the design of sustainable refrigerated facilities for the Olympics (e.g. ice and curling rinks).
- As part of the deployment program, partnerships with provincial governments and utilities have been established with British Columbia and Manitoba, in addition to the existing partnership in Quebec. More than 15 training sessions and workshops were held across Canada to create awareness of and build capacity for innovative refrigeration technologies and practices.

For more information:
cetc-varennes.nrcan.gc.ca/en/ref.html

Equipment: Buildings Program – Intelligent Buildings

Objective: To develop and promote the adoption of intelligent building technologies and innovative building operation practices that reduce energy consumption and GHG emissions.

The program focuses on intelligent building technologies and practices, such as recommissioning, that reduce a building's energy consumption while ensuring the occupants' comfort and preserving indoor air quality. To meet its objectives, the program develops, demonstrates and deploys, in partnership with key stakeholders, intelligent buildings technologies in Canadian commercial/institutional buildings.

Key 2005–2006 Achievements

- Launched demonstration projects of the Continuous Building Optimization approach at several demonstration sites across Canada.
- Training workshop on Continuous Building Optimization performed in Manitoba, in collaboration with Manitoba Hydro.
- Continuous Building Optimization approach and benefits presented to major city representatives, provincial energy managers and to the Conference of the Parties to the Convention (COP-11) delegations.

For more information:
cetc-varennes.nrcan.gc.ca/en/b_b/bi_ib.html

Equipment: Building Energy Simulation Program

Objective: To contribute to the improvement of design, performance, cost-effectiveness, integration and deployment of energy-efficient building technologies and techniques through simulation modelling and applications-driven implementation tools for the market.

Through this program, CETC develops, distributes and supports building simulation software for the Canadian housing and building industry. These software tools are used by architects and engineers to optimize the energy performance of individual technologies and whole-building designs as well as to demonstrate compliance with such programs as the R-2000 Standard, EnerGuide for Houses and (New) Houses, CBIP, *the Model National Energy Code for Buildings* and the *Model National Energy Code for Houses*. CETC is involved in all aspects of the software development process, from design and programming to distribution, maintenance, and user training and support.

CETC developed the next generation of residential energy analysis software, HOT3000™. This is a more advanced version of HOT2000™, with a more comprehensive and expandable simulation engine (based on the ESP-r program). HOT3000 is capable of expanding to meet the complexities of the energy-saving technologies and strategies entering the market and emerging in industry research and development. The ESP-r program was created by the University of Strathclyde in Scotland and modified by CETC to meet Canadian simulation needs. The University of Strathclyde remains a collaborator on several simulation software development projects.

Key 2005–2006 Achievements

- The capacity to model multi-unit residential buildings was added to NRCan's HOT2000 residential energy analysis software.
- CETC continued to play a leading role in developing and validating methods for modelling cogeneration systems by chairing a research annex for the International Energy Agency. The work includes developing models for fuel cells, Stirling Engines, and internal combustion engines within a whole-building simulation program and thus making significant advances in the analysis and study of distributed generation systems for buildings.
- Using CETC software, 200 000 houses and over 500 commercial buildings have been simulated for improved energy efficiency to date.

For more information:
sbc.nrcan.gc.ca/simulation_R_and_D/simulation_R_and_D_e.asp

HOT2000 is an official mark of Natural Resources Canada.

HOT3000 is a Trademark of Her Majesty the Queen in Right of Canada as represented by the Minister of Natural Resources.

Equipment: Distributed Energy Program

Objective: The science and technology direction under this program is to support activities that will lay the foundation for increased use of decentralized energy systems, including electric storage by 2025. These systems will increase the reliability of, and reduce air emissions including GHGs from, Canada's electric power system at an acceptable economic cost to Canadians.

Key 2005–2006 Achievements

- In a joint program with Environment Canada and the cities of Calgary and Kelowna, CETC designed and constructed a trailer that extracted and cleaned landfill gas and produced utility power using a 30-kilowatt microturbine. After 5000 hours of operation on the Calgary landfill site, the trailer was moved to Kelowna, where it has been upgraded by Kelowna to a 3-turbine system.
- In association with Enbridge Gas Distribution and CETC–Varennes, code changes were made to facilitate development of small on-site power plants that served a dual role as providers of both on-site heat and power, and emergency power service.
- A joint program was initiated with the National Research Council and Canadian companies to evaluate and test new electric storage systems and develop new routes to market for these technologies.

For more information:
sbc.nrcan.gc.ca

Equipment: Integrated Energy Systems Laboratory

Objective: To develop advanced concepts and technologies for energy-efficient and low-polluting gas- and oil-fired heating systems for residential and commercial applications.

An area of concentration is integrated systems, where multiple functions are served by one energy source. Significant effort is being expended on ultra-high-efficiency present- and next-generation (ēKOCOMFORT™-type) systems combining space heating, water heating and ventilation. The laboratory can determine the performance of up to six prototype integrated systems. One such unit under development is a high-efficiency condensing fireplace. Another is a highly modulating integrated space-water-ventilating system with advanced learning-based controls.

The laboratory works closely with equipment manufacturers, energy suppliers, end-users, policy and program developers and standards organizations in ensuring rapid development and implementation of the most suitable energy-efficient equipment for the Canadian market.

The laboratory also works on next-generation integrated systems with self-generated electricity using advanced, non-conventional technologies. Prototype thermophotovoltaic and thermoelectric cascaded systems are under development. Here, electricity is generated with no moving parts and the heat is recovered for space/water applications. Gas lighting, whereby light is generated by a highly luminous flame and then transported to applications through light pipes, while the heat is recovered for space/water applications, offers tenfold GHG reductions. Alternative fuels, such as alcohol, bio-fuel and hydrogen are being examined for high-efficiency combustion applications for buildings.

Key 2005–2006 Achievements

- Characterized and developed performance criteria for next generation tankless water heaters with 25 percent energy savings compared to conventional gas-fired water heaters. Worked closely with gas utilities to define criteria for incentive programs for the installation of high-efficiency combustion equipment in residential and commercial applications.
- Optimized fan coil control and monitored performance for high efficiency and homeowner satisfaction as an essential component of the Drake Landing Solar Community project.
- Characterized the high potential for energy efficiency gains exceeding 25 percent with most commercial combustion equipment (rooftops, unit heaters and boilers) with design and operational advances.

For more information:
sbc.nrcan.gc.ca

Communities: Communities and Neighbourhoods Program

Objective: To develop and demonstrate practical decision-making tools, processes and best practices that help communities and developers select more efficient energy, waste and water technologies and design solutions that support each community's journey towards a sustainable energy future.

Communities impact about 50 percent of energy consumption in Canada. Within communities, buildings consume 63 percent of all natural gas (including 9 percent used for electricity) and 53 percent of all electricity, which also means that they account for roughly 53 percent of the coal burned for electricity production. The program examines how communities can function as an integrated energy-consuming whole while contributing to municipalities' broader goals of encouraging more sustainable development. The goal is to contribute to sustainable development initiatives by stakeholder groups by supporting the development and use of practical decision-making tools, processes and best practices that will help communities and developers select appropriate energy-efficient technologies and design solutions and help guide each community's journey towards a sustainable energy future.

The Communities and Neighbourhoods Program works with provincial governments, municipal stakeholders, other government departments and private sector developers to facilitate the adoption of sustainable community development principles and community energy systems. Opportunities to effect change arise through innovative projects that are geared to the Canadian context and are launched in the following areas: combined heat and power technologies; district energy generation systems (including integration of renewables); computational and other tools that consider energy consumption within and emissions from the community from a system's perspective; processes that guide the creation of community strategies based upon energy efficiency and the reduction of GHGs; methods that assist decision-makers to differentiate between urban development alternatives on the basis of their environmental impact on the community; and community energy standards that support policies, codes and technical standards for energy-efficient development practices.

Key 2005–2006 Achievements

- A number of large-scale district energy systems are under construction or at the design stage across Canada. A range of technologies are being demonstrated to reduce energy consumption, including gas-fired combined heat and power, ground-source heat pumps, and lake-cooling and solar thermal applications.
- NRCan's *Community Energy Planning Guide* was released in May 2005 and has prompted a number of municipalities to develop municipal energy plans.
- A model Sustainable Urban Planning process developed in consultation with municipal and developer stakeholders will be applied in a pilot large-scale, sustainable urban development in Edmonton, Alberta.

For more information:
sbc.nrcan.gc.ca

Chapter 5: Industry

Energy Use and Greenhouse Gas Emissions

The industrial sector includes all manufacturing industries, all mining activities, forestry and construction; however, it excludes electricity generation. This sector uses energy in industrial processes as a source of motive power to produce heat or to generate steam. Overall, industrial energy demand accounts for 38.4 percent (3277 petajoules) of secondary energy use and 33.6 percent (170 megatonnes) of greenhouse gas (GHG) emissions (including electricity-related emissions).

Within the industrial sector, energy is consumed primarily in pulp and paper, mining, petroleum refining, and smelting and refining industries. Pulp and paper alone accounted for about 26.7 percent of total industrial energy demand in 2004 (see Figure 5-1).

In most industries, energy purchases account for only a small proportion of total expenditures. However, for some relatively energy-intensive industries – cement, aluminum, pulp and paper, iron and steel, and chemicals – this share is higher than 11 percent (see Figure 5-2). For cement, in particular, the share is as high as 38.7 percent.

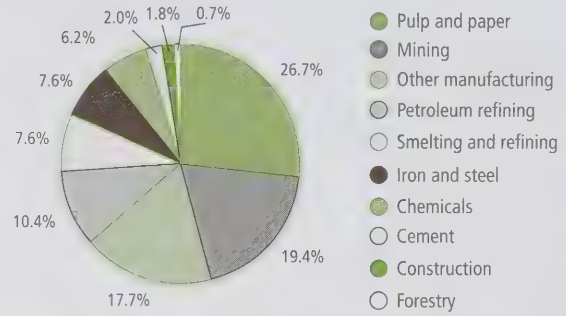
Actual industrial energy use increased by 20.6 percent (560 petajoules) between 1990 and 2004. This increase was driven by a 40.4 percent increase in industrial activity, measured as a combination of physical units of production, gross output and gross domestic product (GDP). However, some of this increase in energy use that would have resulted from the increase in activity was offset by improvements in energy efficiency and structural change – the shift to less energy-intensive industries (such as electrical and electronics).

Three main factors influenced energy use:

- activity – increases in physical units of production, gross output and GDP contributed to a 40.4 percent increase in industrial activity resulting in a 1098-petajoule increase in energy use.
- structure – the change in the mix of activity toward less energy-intensive industries resulted in a 224-petajoule decrease in energy use.

FIGURE 5-1

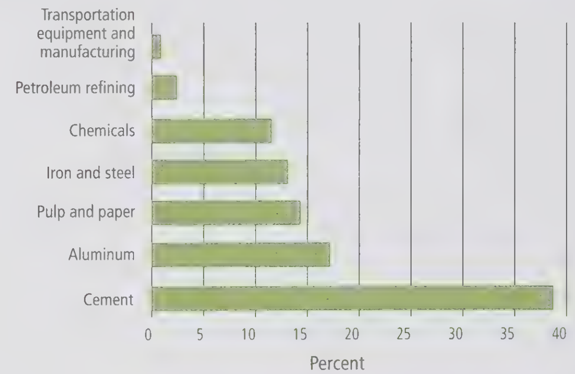
Industrial Energy Use by Sub-Sector – Including Electricity Related Emissions,* 2004



*Note: The above sub-sectors reflect the current definitions in the *Report on Energy Supply-Demand in Canada*. "Other manufacturing" comprises more than 20 manufacturing industries.

FIGURE 5-2

Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2004

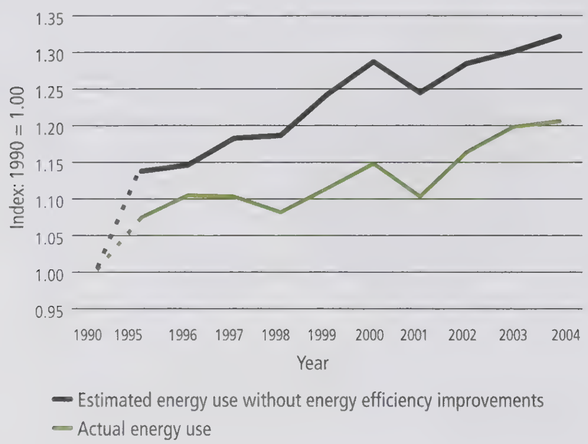


- energy efficiency – due to an 11.5 percent improvement in energy efficiency, the industrial sector avoided 314 petajoules of energy use between 1990 and 2004.

The change in energy use between 1990 and 2004 and the estimated energy savings due to energy efficiency are shown in Figure 5-3.

FIGURE 5-3

Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004



Between 1990 and 2004, industrial GHG emissions including electricity-related emissions increased by 19.7 percent. Excluding electricity-related emissions, industrial GHG emissions increased by 13.2 percent over the same period. Most of this increase in direct GHGs occurred in the upstream mining industry, since the mining (excluding upstream), manufacturing and construction industries realized a 2.7 percent decrease in GHG emissions.

Natural Resources Canada (NRCan) delivers initiatives to increase energy efficiency in the following components of the industrial sector:

- industrial processes and technologies
- equipment (refer to Chapter 2)
- buildings (refer to Chapter 4)

Industrial Processes and Technologies: Industrial Energy Efficiency (Canadian Industry Program for Energy Conservation [CIPEC] and Industrial Energy Innovators [IEI])

Objective: To help Canadian industry use energy efficiency investments to improve productivity and competitiveness and to contribute to Canada's climate change goals.

CIPEC is a unique industry-government partnership committed to promoting and encouraging energy efficiency improvements and reductions in GHG emissions through voluntary action across Canada's industrial sectors, including the mining, manufacturing, forestry, construction, upstream oil and gas, and electricity generation sectors.

CIPEC's network comprises 26 sector task forces (including four regional) that share information and best practices; more than 1000 Industrial Energy Innovators (companies that have made a written voluntary commitment to become more energy efficient and support Canada's climate change initiatives); and partnerships with 52 industry associations that disseminate information and advice on energy efficiency to their members.

CIPEC's multi-faceted approach focuses on introducing technological innovations, bringing about behavioural change, and shifting organizational culture to generate a sustainable market transformation. Tools and services offered through CIPEC include energy fora and conferences; communications products including Web sites and newsletters, technical guidebooks, energy benchmarking and best practices studies; Dollars to $ense energy management workshops; cost-shared energy audits and Process Integration studies; and provision of technical information relating to the eligibility of renewable energy and/or energy efficiency systems for accelerated capital cost allowances under Class 43.1 and Class 43.2 of the *Income Tax Act*.

Key 2005–2006 Achievements

- Between 1990 and 2004, CIPEC industries improved their energy intensity by 9.1 percent and avoided 29.5 megatonnes of GHG emissions (see Figure 5-4). Adoption of CIPEC tools and services between 2001 and 2005 is estimated to have saved 13.5 petajoules in 2005 (see Figure 5-5).
- Recruited 338 new Industrial Energy Innovators, bringing the total number of facilities and companies registered to more than 1000. Initiated 221 industrial energy audits, which is more than double the target of 100 set for this Action Plan 2000 measure.
- As shown in Figure 5-6, 1051 industrial clients participated in Dollars to $ense energy management workshops. The jump between 2003 and 2004 was due to the significant increase in customized workshops.

FIGURE 5-4

CIPEC Energy Intensity Index, 1990 to 2004

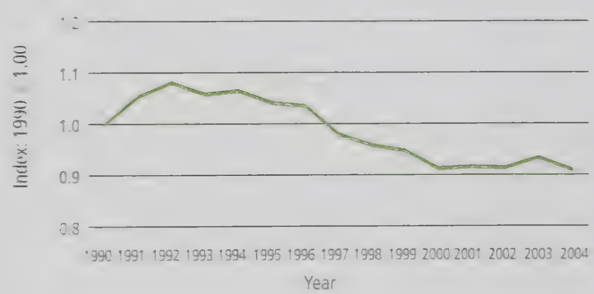
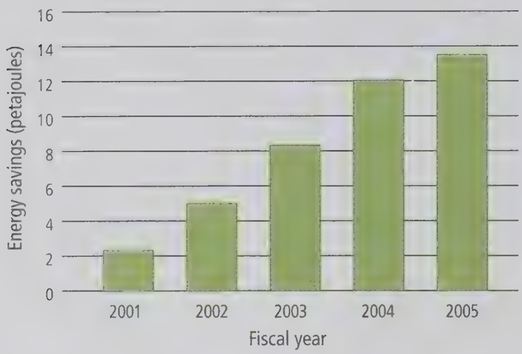


FIGURE 5-5

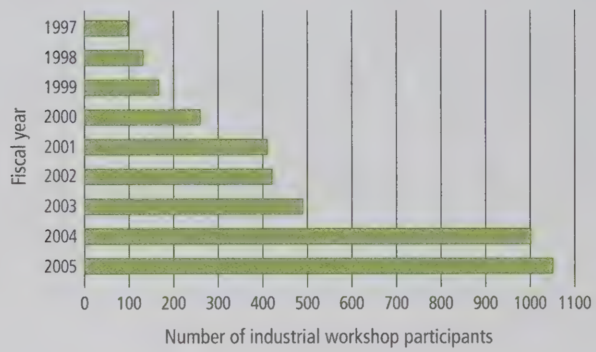
Estimated CIPEC Energy Savings, 2001 to 2005



For more information:
oee.nrcan.gc.ca/industrial/cipec.cfm

FIGURE 5-6

Industrial Dollars to $ense Participants, 1997 to 2005



Industrial Processes and Technologies: Clean Electric Power Generation

Objective: To design, develop and deploy technologies for power generation from fossil fuels with increased efficiency and reduction and ultimately elimination of emissions of acid rain precursors, GHGs, particulates and identified priority substances – mercury, trace elements and organic compounds.

Research focuses on improving performance of and reducing emissions from existing fossil fuel power plants and on developing new advanced cycles for conversion of fossil fuels to electricity with complete or nearly complete capture and elimination of carbon dioxide (CO_2) and other emissions. Issues covered by other research projects include the transport and storage of CO_2.

Key 2005–2006 Achievements

- Developed a coordinated and integrated approach to address opportunities and priorities related to industrial combustion processes with the potential to reduce energy use and emissions by between 15 and 50 percent. Government and industry players have shown considerable interest in participating.
- The U.S. Department of Energy has recognized the new Pressurized Gasification Laboratory as the world's foremost small pilot-scale research facility.
- Developed a new generation of computational fluid dynamics software, simulated 12 coal-fired boilers, and established training courses as part of an international collaborative venture to reduce CO_2 emissions from utility boilers in China.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/Groups/clean_electric_power_generation_e.htm

Industrial Processes and Technologies: Processing and Environmental Catalysis Program

Objective: To solve industrial process problems and undertake research in areas with high potential for significant environmental and economic benefits.

The Program's facilities, including semi-pilot-scale plants, are used for process testing and the evaluation of novel concepts in chemical and energy conversion, including hydrogen production from hydrocarbon and renewable sources. Clients include oil and gas companies, petrochemical companies, engine manufacturers, waste oil recyclers and renderers, and specialty ceramic manufacturers.

Key 2005–2006 Achievements

- Developed technology for desulphurizing diesel fuel that is produced by thermally cracking waste lubricating oil. A bench-scale continuous processing unit was commissioned for testing the CANDES process. The project has support from the waste oil recycling industry.
- Completed catalyst evaluation for producing olefins by catalytic cracking of hydrocarbon feedstocks. Catalyst testing was conducted for Valeo, a technology development company with proprietary catalyst technology. The results will be used to secure industrial partnerships.
- Developed a direct ammonia fuel cell for efficient combined heat and power applications. Bench-scale fuel cell development is being undertaken by three federal labs.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/Groups/Research%20Programs/processing_and_environmental_catalysis_e.htm

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Industrial Processes and Technologies: Industrial System Optimization Program

Objective: To support the development and adoption of innovative energy-efficient design practices in Canadian industry to improve energy efficiency and productivity while reducing GHG emissions and other environmental impacts.

The Program focuses on plant-wide industrial process analysis techniques, such as Process Integration (PI) and advanced process control systems, to identify and correct inefficiencies in plant operation and design with due consideration for energy, economy and environmental factors. It seeks to meet its objective by conducting leveraged research and development through national and international cooperation. Furthermore, the Program disseminates technical information to encourage adoption of these techniques and practices in targeted energy-intensive sectors of Canadian industry, including pulp and paper, oil upgrading and refining, petrochemicals, steel, chemicals, food and drink, and solid wood.

Key 2005–2006 Achievements

- NRCan designed, proposed and demonstrated a national PI program to publicize, promote and implement sound PI practices in the Canadian industry infrastructure (both large final emitter and non-large final emitter sectors). Under such a comprehensive program, GHGs would be reduced by an estimated 10 megatonnes of CO_2 equivalent per year, businesses would become more competitive by reducing their energy and water expenditures resulting in annual energy-cost savings of about $1 billion, the implementation of identified savings would result in significant economic spin-offs of around $6 billion and a reduced environmental footprint, and Canadian industry

stakeholders would be given the knowledge and tools needed to make PI standard practice in Canada. The program represents a major opportunity to change the way energy analysis is currently conducted in the industry, thereby improving productivity and competitiveness.

- Development of guidelines for Combined Energy and Water Optimization for the pulp and paper industry. A clear methodology was developed to identify and improve water and energy utilization in Kraft mills, with a novel approach to the analysis of non-isothermal mixing points, which can be a very significant source of energy losses in the pulp and paper industry. Also prepared an opportunity analysis document for projects around the site-wide energy and water optimization theme for the oil sands, based on successful experiences in the pulp and paper sector.
- Struck a partnership with the Natural Sciences and Engineering Research Council of Canada Environmental Design Engineering Chair and initiated an agreement with École Polytechnique de Montréal and several leading pulp and paper companies to create a unique body of expertise in the area of pulp and paper. The Chair's project is entitled "Optimizing the Carbon Value Chain in the Pulp and Paper Process Biorefinery." It will use its core competency in PI to evaluate how pulp and paper mills can evolve so that they not only survive but also prosper.

For more information:
cetc-varennes.nrcan.gc.ca/en/indus.html

Industrial Processes and Technologies: Industry Energy Research and Development (IERD) Program

Objective: To encourage and support the development and application of leading-edge, energy-efficient and environmentally responsible processes, products, systems and equipment in industry.

Financial support is provided for commercially confidential applied research and development (R&D) activities. The funds are repayable if the project is commercially successful. Program clients from all industrial sectors range from small- and medium-sized companies to multinational corporations.

Key 2005–2006 Achievements

- With the financial support of IERD, MagCasTec Inc. of Strathroy, Ontario, is developing an ingot preheater for the magnesium and aluminum casting industries that will preheat ingots with waste heat from the top of melting furnaces rather than electric heaters. It is projected that a preheater will reduce electricity consumption by 1.7 terajoules per year and GHG emissions associated with electricity generation by 94 tonnes per year. In magnesium casting applications, it is projected that each preheater will reduce sulphur hexafluoride consumption by 10 percent for a CO_2 equivalent reduction of 28 000 tonnes per year.
- Mining Technologies International of Sudbury, Ontario, is developing an energy-efficient diesel/electric hybrid scoop tram for mining operations. This hybrid system alone could improve the air quality in the underground mine environment by a factor of 60 percent. Potential annual energy savings range from 824 gigajoules in the first year of commercialization to 272 terajoules in year 10. Cumulative savings are of the order of 1.4 petajoules over the same period.
- S.O.E. Inc. of St-Mathieu-de-Beloeil, Quebec, is developing a new toroidal, continuously variable transmission to increase the efficiency of diesel engines operating generator sets. Projected energy savings for genset application are 15 to 25 percent (setup-dependent), with an engine life increase of 25 percent. Potential energy savings over 10 years are 46 petajoules, with a CO_2 reduction of 9.4 megatonnes.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/Publications/ierdpublications/factsheet_industry_energy_r&d_e.htm

Industrial Processes and Technologies: Emerging Technologies Program (ETP)

Objective: To support the identification and demonstration of new and emerging energy-efficient technologies.

Projects are co-managed and cost-shared with industry and other stakeholders, such as gas and electric utilities, other governments and equipment manufacturers. Financial support is provided for the development and testing of pilot plants and prototypes and for full-scale field trials to evaluate operating performance, energy efficiency and environmental impacts. NRCan's financial support is repayable from any cost savings or revenues generated by a project.

Key 2005–2006 Achievements

- ETP supported Sirex Engineering of Bolton, Ontario, for the development and demonstration of an automated production line to recycle and convert post-industrial cross-linked polyethylene foam scrap into laminated sheet foam products. The process will save energy and will reduce GHG emissions by not having to make new foam. Emissions will be further reduced because incineration of scrap foam will be cut back, and there will be less pressure on landfills because less scrap will be transported to them.
- Groupe Énerstat of Bromptonville, Quebec, with contributions from ETP, completed a field trial of its phase-change thermal storage system in the chilled water plant at the IBM Canada Ltée. plant in Bromont, Quebec. The system reduced electrical annual energy and natural gas energy inputs for the plant by 19 terajoules for a combined energy savings of 46 percent and an estimated annual GHG emissions reduction of 232 tonnes.
- With the financial support of ETP, Custom Dry Kiln (CDK) of Port Coquitlam, British Columbia, was able to demonstrate that dehumidification lumber kilns were substantially more energy efficient than traditional lumber drying kilns when drying large quantities of softwood dimensional lumber (2.1 gigajoules per thousand board feet compared with 2.4 gigajoules per thousand board feet). Additionally, CDK showed that dehumidification kilns make it possible to capture a high proportion of volatile organic compounds (VOCs) released by the lumber in the condensate, leaving relatively low levels of VOCs in the kiln atmosphere.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/funding_programs_etp_e.html

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Industrial Processes and Technologies: Industrial Energy Innovation

Objective: To assist major industrial energy consumers to reduce the energy intensity of their operations and to reduce GHG emissions and emissions of other air pollutants, while enhancing competitiveness and profitability.

Industrial combustion processes are the major sources of industrial GHG emissions. Because most industrial furnaces operate at extremely low thermal efficiencies of 15 to 50 percent, there are major opportunities to improve industrial energy efficiency and productivity while significantly reducing GHG emissions.

NRCan's work in this area includes changing the interaction of the combustion system within the process through advanced tools and technologies. NRCan held technical workshops with major industry sectors (steel, mining, smelting and refining, cement, lime, and pulp and paper) and with CIPEC, industrial associations and individual companies to help define and map partnerships for a generic industrial combustion R&D program and applications to take advantage of these opportunities in order to achieve potential energy and GHG reductions of 10 to 50 percent and more. In addition, NRCan is engaged in developing generic tools and technologies that cross industry sectors, fuels and furnaces.

Key 2005–2006 Achievements

- Developed a computer model of a football-field-sized induration furnace and validated the model with field

data. In doing so, identified the opportunity for major reductions in energy consumption (>50 percent) and comparable reductions in pollutant emissions, including GHGs, with the potential for dramatic operating cost savings.

- Using advanced laser-based flame analysis, developed a novel burner suitable for converting a large energy-intensive industrial glass furnace from expensive natural gas to waste petroleum coke, with no change in production or product quality. With successful adoption on one furnace, the client is now converting all of its furnaces using this concept.
- Developed a sophisticated computer model for flame visualization, using movie animation techniques, which will facilitate intuitive data analysis for performance enhancement and energy savings. The tool will enable rapid transfer and acceptance of computational fluid dynamic modelling results directly by plant and consulting engineers and equipment designers of industrial combustion facilities.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/Groups/industrial_innovation_e.htm

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Industrial Processes and Technologies: Minerals and Metals Program

Objective: To reduce GHG emissions from Canada's minerals and metals sector by enhancing mineral and metal recycling processes and practices, by encouraging replacement of cement in concrete with supplementary cementing materials (SCMs), and by assessing alternate production processes.

The Minerals and Metals Program is managed by CANMET Mineral Technology Branch and is part of the *Government of Canada Action Plan 2000 on Climate Change*. This five-year program, which was assigned a GHG emissions reduction target of 1.65 million tonnes of CO_2 equivalent per year by 2010, wrapped up in March 2006. It consisted of (1) the Enhanced Recycling component, which aims to increase Canada's potential to recycle all materials by developing new approaches and improving upon existing recycling infrastructure, practices and policies; and (2) the Enhanced Emission Reductions for Minerals and Metals component, which supports activities to increase the use of SCMs in concrete and thus replace portland cement (thereby reducing the GHG emissions of concrete production) and which examines processes to gain a greater understanding of them and thereby generate new emission reduction opportunities in the minerals and metals industry sector.

Key 2005–2006 Achievements

- As part of the wrap-up of the Enhanced Recycling Program, a two-day workshop was held in Ottawa to discuss the performance of the program and next steps, which involved providing input for a "National Strategy on Resource Recovery and Recycling." The workshop was attended by 65 experts from across Canada and a report was produced outlining key issues for future consideration.
- In partnership with Environment Canada and ICF Consulting, the Minerals and Metals Program supported the development of a study entitled *Determination of the Impact of Waste Management Activities on Greenhouse Gas Emissions*, which will be an important tool for decision-makers comparing the GHG implications of different end-of-life management strategies for materials found in the waste stream.
- The Association of Canadian Industries Recycling Coal Ash presented a cross-Canada series of workshops with a regional focus to demonstrate the latest information on the technical and performance benefits of SCMs in concrete, as well as new industry guidelines/standards and their significance for practices.

For more information:
recycle.nrcan.gc.ca
nrcan.gc.ca/mms/canmet-mtb/mtl/research/concrete_e.htm
scm.gc.ca

Industrial Processes and Technologies: Mine Ventilation

Objective: To reduce energy consumption and GHG emissions associated with mine ventilation through infrastructure automation (to support demand-based delivery systems), ventilation network optimization and management, and less air-volume-demanding technology.

Ventilation is required in underground mines to maintain a safe working environment because it dilutes and removes harmful pollutants (dusts and gases) and provides a thermally suitable working climate. However, providing sufficient suitable ventilation can account for 40 percent of the energy consumed underground by a mining operation. Mine ventilation systems naturally include some redundancy to accommodate all the available production locations. The degree and implications of this oversupply are highly dependent on the individual mine, mineral and mining method. Metal mines that were traditionally designed to operate at maximum delivery – i.e. peak demand across all potential production locations 24 hours a day, 7 days a week – are now starting to adjust ventilation systems to match actual production needs. Energy savings at less than peak demand range from linear for the heating/cooling systems through to a cubic relationship for the primary fan system. Optimizing energy use, GHG emission reductions and cost is not a straightforward proposition, as it depends on the specific consumption profile (i.e. electricity versus heating fuels and primary versus secondary delivery systems), the design criteria and geographic location of each mine and therefore requires evaluation on a case-by-case basis.

Key 2005–2006 Achievements

- In order to assess potential cost, energy requirements and GHG reduction strategies, CANMET – Mining and Mineral Science Laboratories continued to develop a process-based modelling approach for determining ventilation needs as a function of the life of the mine. This will enable mine management to select, on an on-demand basis, the level of ventilation that is appropriate to support production and to dilute contamination. The same model could be used to better evaluate the benefit of various ventilation reduction options, such as fuel cells and other clean engine technologies. A model for one type of mine has been completed.
- The implementation of ventilation on demand at an Inco mine continues. The mine has installed monitoring information to track vehicle movement and energy usage, along with a proof-of-concept automated secondary ventilation system.

For more information:
nrcan.gc.ca/mms/canmet-mtb/mmsl-lmsm/mines/air/air-e.htm

Chapter 6: Transportation

Energy Use and Greenhouse Gas Emissions

The transportation sector consists of three sub-sectors: passenger, freight and off-road. Passenger and freight transportation accounted for 54.1 percent and 42.0 percent, respectively, of transportation energy use, with off-road representing only 3.9 percent in 2004. The passenger sub-sector is composed of three modes: road, rail and air. The freight sub-sector, as defined by Natural Resources Canada (NRCan), is composed of road, rail, air and marine. Road transport uses the most energy, accounting for 78.3 percent of total transportation energy use in 2004. Of this amount, 56.8 percent was passenger energy use and 43.2 percent was freight energy use (see Figure 6-1).

All NRCan transportation energy-use programs focus on the energy used in road transportation. Total transportation energy use increased by 31.3 percent (587 petajoules) over 1990 to 2004 (see Figure 6-2). Passenger transportation energy use increased by 17.1 percent (195 petajoules), while freight transportation energy use increased by 51.1 percent (350 petajoules).

Three main factors influenced energy use:

- activity – due to increases in population and economic activity, there was greater transportation activity (measured as passenger-kilometres for passenger transportation and tonne-kilometres for freight transportation). This increased transportation energy use by 35.7 percent (670 petajoules). The freight and passenger segments contributed to this increase by 52.0 percent and 48.0 percent, respectively.
- structure – shifts between modes of transport within both the freight and passenger segments resulted in an increase of 10.5 percent in transportation energy use (197 petajoules). The effects of mode shifting were more pronounced in the freight segment since freight truck activity is growing significantly faster than rail and marine.
- energy efficiency – improvements in energy efficiency worked to decrease energy use by 16.8 percent (315 petajoules).

Without improvements in energy efficiency, increases attributable to activity and structure would have led to an increase in transportation energy use of 48.0 percent (867 petajoules). However, as a result of improvements in energy efficiency, actual energy use increased by 31.3 percent. This change in energy use between 1990 and 2004, as well as the estimated energy savings due to energy efficiency, is shown in Figure 6-2.

FIGURE 6-1

Transportation Energy Use by Mode, 2004

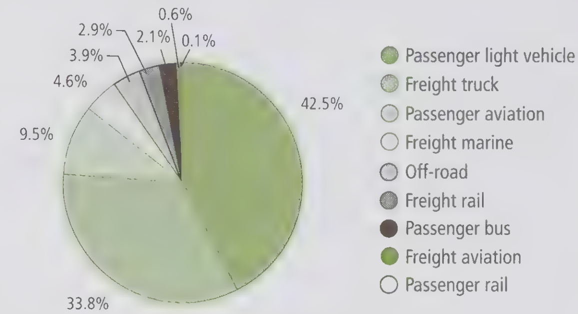
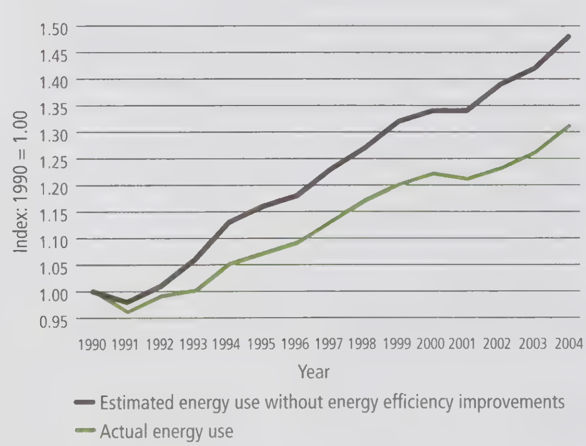


FIGURE 6-2

Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004



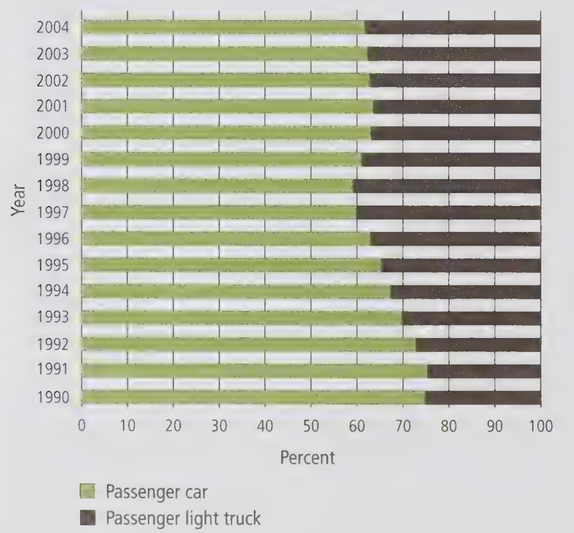
The transportation sector accounts for 28.9 percent (2465 petajoules) of secondary energy use and 34.9 percent (176 megatonnes) of greenhouse gas (GHG) emissions. From 1990 to 2004, transportation energy use increased by 31.3 percent, and GHG emissions increased by 30.6 percent. The change in GHG intensity of transportation energy use was negligible.

Figure 6-3 shows how the market share of new light trucks increased in the 1990s, reflecting the growth in popularity of minivans and sport-utility vehicles. Figure 6-4 demonstrates that, on a per-kilogram or per-unit-of-horsepower basis, fuel efficiency has improved markedly. However, average fuel economy has been stable because new vehicles continue to be heavier and have more powerful engines.

Figures 6-5 and 6-6 illustrate an improvement in trucking energy intensity despite an increase in average activity over 1990 to 2004. Improved fleet practices, caused by an increase in the competitiveness of the transportation sector and by the introduction of electronic engines, have significantly improved engine fuel efficiency in medium-duty and heavy-duty trucks.

FIGURE 6-3

Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2004



NRCan delivers initiatives in the following areas to increase the efficiency of motor vehicles and encourage the use of alternative fuels:

- vehicles
- transportation research and development
- alternative transportation fuels
- transportation technologies

FIGURE 6-4

New Car Fuel Efficiency, Normalized for Weight and Power, 1990 to 2003

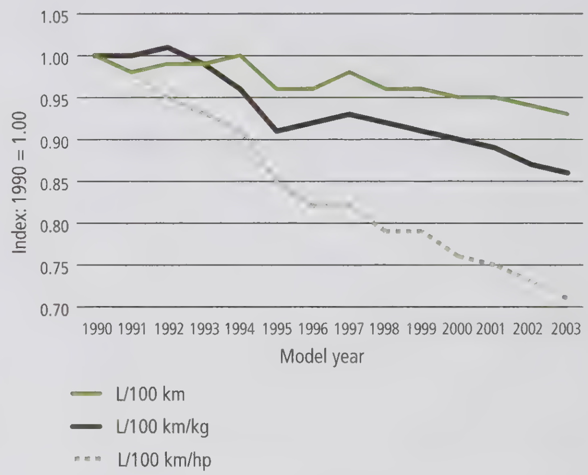


FIGURE 6-5

Average Activity per Truck (tonne kilometres/truck), 1990 to 2004

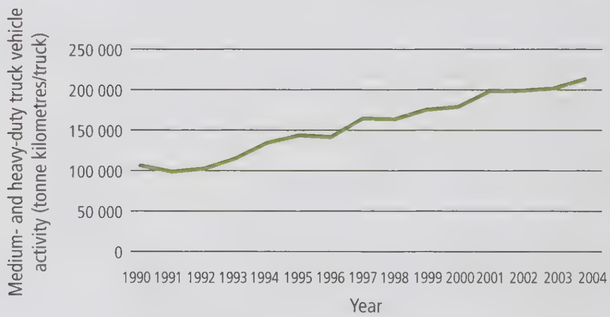
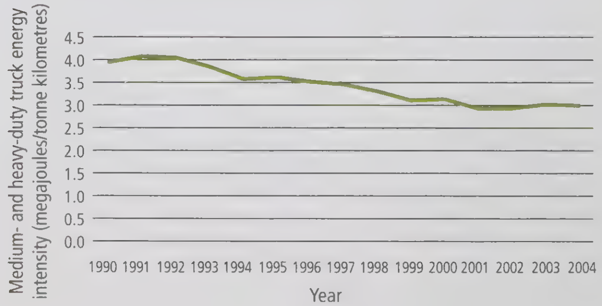


FIGURE 6-6

Trucking Energy Intensity, 1990 to 2004



Vehicles: Vehicle Efficiency

Objective: To improve the fuel efficiency and reduce the GHG emissions of new light-duty vehicles sold in Canada.

The goal of the Motor Vehicle Fuel Efficiency Initiative is to bring about a 25 percent improvement in the fuel efficiency of new light-duty vehicles sold in Canada by 2010. NRCan led negotiations with the automotive industry to a successful conclusion, reaching an agreement to reduce GHG emissions from this sector. The auto industry committed to a voluntary reduction in GHG emissions of 5.3 megatonnes (Mt) annually from light-duty vehicle use by 2010. This 5.3 Mt target goes beyond fuel consumption reductions by incorporating reductions in all GHG emissions associated with vehicle use.

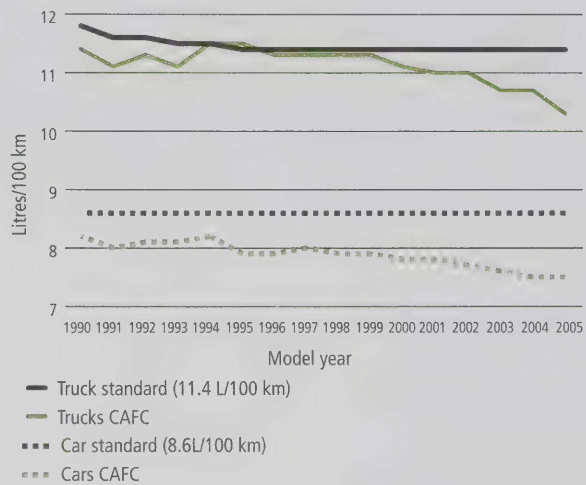
Key 2005–2006 Achievements

- Established the Joint GHG Memorandum of Understanding (MOU) Committee, a committee responsible for tracking automotive industry progress towards the 5.3-Mt reduction target by 2010:
  - Terms of Reference and Operational Plan finalized
  - Committee's first progress update produced
  - Committee's communications strategy developed
  - Stakeholder engagement options put forward by government members of the Committee
- Developed an accounting tool for use by Joint GHG MOU Committee to track industry's progress towards the 5.3-Mt reduction target:
  - Identified data needed to track progress and assessed submission and reporting requirements
  - Completed accounting framework and review of data sources to populate the accounting tool

For more information:
oee.nrcan.gc.ca/transportation/fuels/motorvehicles.cfm

FIGURE 6-7

Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards, 1990 to 2005*



*2002–2005 data are estimates

Vehicles: EnerGuide for Vehicles

Objective: To improve motor vehicle fuel efficiency by encouraging private motorists to purchase energy-efficient vehicles.

EnerGuide for Vehicles promotes the purchase of fuel-efficient vehicles in order to reduce vehicle emissions and mitigate other vehicle-related environmental impacts. It offers a series of tools to help Canadian motorists consider fuel efficiency in their vehicle purchase decisions and encourages buyers to choose the most fuel-efficient vehicle that meets their everyday needs.

Each year, the free *Fuel Consumption Guide* provides fuel consumption ratings and the estimated annual fuel cost, fuel consumption and carbon dioxide (CO_2) emissions for new passenger cars, light-duty pickup trucks, vans and special purpose vehicles sold in Canada. The EnerGuide label, which is affixed to the side window of new light-duty vehicles sold in Canada, provides specific fuel consumption information for each model. Every year, the EnerGuide for Vehicles Awards recognize the most fuel-efficient vehicles in nine categories. Awards are presented to the manufacturers.

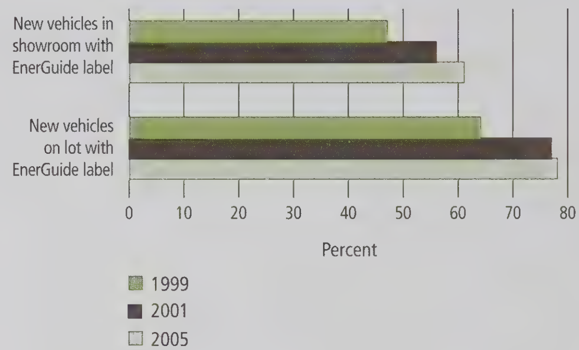
A buyer's guide for fuel-efficient vehicles is being prepared. This new tool will educate automobile consumers about the impact of vehicles on the environment and help them select the most fuel-efficient vehicle that meets their everyday needs.

Key 2005–2006 Achievements

- NRCan completed a marketing study to determine the most effective strategy for raising Canadians' awareness. Elements of the strategy are already in the implementation phase and include partnerships with dealership associations and participation at auto shows:
  - In collaboration with the Canadian Automobile Dealership Association, partnerships and pilot projects were developed with the Montreal Association of New Car Dealers and the Manitoba Motor Dealers Association to promote fuel-efficient vehicles.
  - EnerGuide for Vehicles exhibited at the Toronto, Montréal and Vancouver major auto shows, as well as the Lanark Auto Show, the Barrie Auto Show, the AJAC Test-Fest, the Conference of the Parties to the Convention (COP-11), the Calgary Auto Show, and the Québec City auto show.
- Over 325 000 copies of the *Fuel Consumption Guide* were distributed, including 186 000 to 3386 new car dealerships and 53 000 to 1412 Canadian Automobile Association offices.
- NRCan presented a New Vehicle Recognition System to Government Industry Motor Vehicle Efficiency Committee. Its purpose is to provide a visible signal directing consumers and fleets to the purchase of fuel-efficient and low-CO_2-emitting vehicles.

FIGURE 6-8

Vehicle Fuel Efficiency – EnerGuide Labelling



For more information:
oee.nrcan.gc.ca/vehicles

Vehicles: Personal Vehicles

Objective: To improve motor vehicle fuel conservation by encouraging private motorists to develop energy-efficient vehicle use and maintenance practices.

The Personal Vehicles information initiative promotes improvements in vehicle fuel efficiency, reductions in vehicle emissions, and the mitigation of other vehicle-related environmental impacts. The initiative helps motorists understand how driving and maintenance behaviours affect GHG emissions and the environment. It encourages Canadians to adopt energy-conserving driving techniques and maintenance practices. The initiative complements EnerGuide for Vehicles.

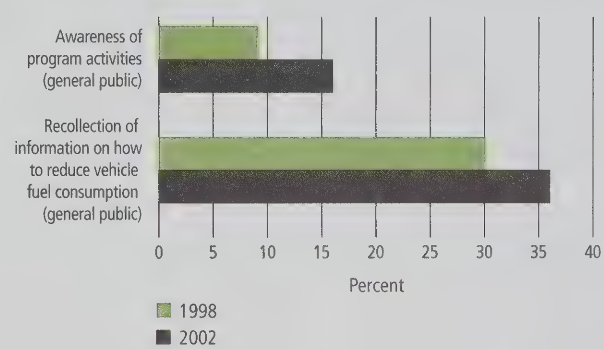
Key components include the Auto$mart "A New Point of View" Driver Educator kit, which provides instructors with the instruments (instructor's in-class materials, student workbook, instructor's in-car guide, video, CD-ROM, and student tips cards) to teach fuel-efficient driving to drivers; the Idle-Free Campaign, which seeks to curb vehicle idling; and the Be Tire Smart Campaign, developed in collaboration with the Rubber Association of Canada, which encourages Canadians to adopt good tire maintenance and inflation practices. Recently, the initiative has been working with Transport Canada as well as the private and public sectors to explore the potential for initiatives to encourage Canadian motorists to adopt good speed management, driving and maintenance practices.

Key 2005–2006 Achievements

- Provided Auto$mart Train-the-Trainer workshops to 835 driving instructors of the 2172 driver educators who received the Auto$mart "A New Point of View" driver education resource kit. Since its launch in 2005, driving instructors have trained 130 320 new drivers on safe, fuel-efficient vehicle operating practices. Negotiated with provinces and territories to encourage the adoption of fuel conservation and efficiency components into their driver education and licensing infrastructure. Since 2002, a total of 23 fuel efficiency components have been implemented in various jurisdictions across Canada.
- Completed an Idle-Free campaign with the Halifax Regional Municipality and initiated an Idle-Free campaign with the City of Vancouver. Completed the development of regulatory and voluntary approaches to addressing idling with the Clean Air Partnership. Since its launch in 2001, the Idle-Free initiative has cooperated with nine municipalities, six community groups, and other organizations to deliver idle-free campaigns to over 9.8 million Canadians.
- Extended the Be Tire Smart campaign, in association with the Rubber Association of Canada, Nova Scotia and Alberta. The over 100 articles on the campaigns have had a circulation of 7.2 million and reached 16.3 million Canadians.

FIGURE 6-9

Vehicle Fuel Efficiency Awareness – Program Activities



For more information:
vehicles.gc.ca

Vehicles: Fleet Vehicles

Objective: To improve the fuel efficiency and reduce the GHG emissions in commercial and institutional road transportation fleet operations and all other non-Government of Canada vehicle fleets through energy efficiency practices and the use of alternative fuels.

Fleet Vehicles provides information materials, workshops, technical demonstrations, driver and manager training programs and special projects, such as the truck stop Idle-Free – Quiet Zone Campaign, to help fleet operators assess and pursue opportunities to increase energy efficiency in their operations. To increase market penetration of fuel-efficient and emission-reduction technologies, the Fleet Vehicles initiative also provides financial incentives to commercial fleets purchasing pre-selected anti-idling technologies (see Figure 6-10). NRCan delivers the Fleet Vehicles initiative in partnership with fleets, industry stakeholders and other levels of government.

Key 2005–2006 Achievements

- To date, the Fleet Vehicles initiative has registered over 4733 members (see Figure 6-11). The annual truck stop Idle-Free – Quiet Zone Campaign was successfully conducted at more than 80 sites across Canada.
- A fourth driver training curriculum, "SmartDriver for Motor Coach," has been added to the SmartDriver family of tools. The Fleet Vehicles initiative has also introduced a new SmartDriver Self-Study Module.
- The Fleet Vehicles initiative and the U.S. Environmental Protection Agency signed a Memorandum of Understanding under which the freight industry in both countries would be encouraged/assisted to undertake voluntary actions to reduce fuel consumption and protect the environment with verifiable emissions reductions and, at the same time, cooperation and expansion of current activities would be promoted.

For more information:
fleetsmart.nrcan.gc.ca

FIGURE 6-10

Number of Idling Reduction Devices Purchased and Claimed Under Commercial Transportation Energy Efficiency Rebate (CTEER) Initiative

	2004–2005*	2005–2006
Auxiliary Power Units (APUs)	1342	5376
Heaters	9323	1202

*2004–2005 total includes initial six-month program launch in 2003–2004

FIGURE 6-11

Participation in the Fleet Vehicles Initiative, 1998 to 2005

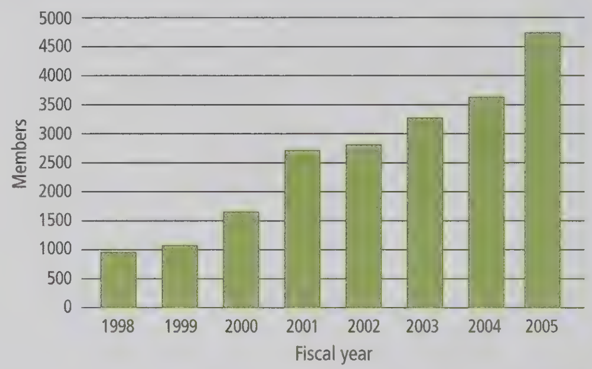
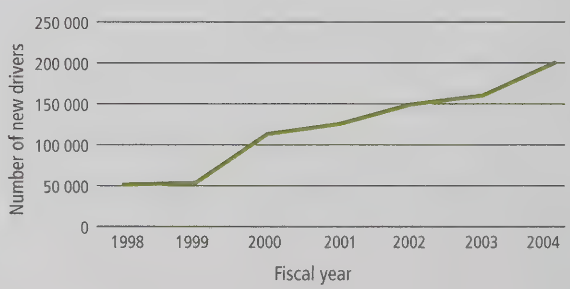


FIGURE 6-12

Drivers Trained, 1998 to 2004*



*Estimates based on NRCan internal data

Transportation Research and Development: Canadian Lightweight Materials Research Initiative (CLiMRI)

Objective: To develop low-density, high-strength, lightweight materials to achieve weight reductions in ground transportation vehicles.

CLiMRI is a research network comprising 29 companies, eight universities and seven government departments and funding agencies. CLiMRI's goal is to develop and implement lightweight and high-strength materials with transportation applications for the purpose of reducing GHG emissions through vehicle weight reduction and improving vehicle efficiency, and enhancing the competitiveness of Canadian primary metals producers, automotive part manufacturers and suppliers.

Key 2005–2006 Achievements

- Magnesium sheet alloys are increasingly being considered for automotive applications because of the potential for weight reduction, fuel economy improvement and emission reduction. To facilitate the use of magnesium sheet alloy for automotive applications, it is necessary to characterize formability as a function of temperature and deformation rate for the different alloys and thermo-mechanical processing routes of interest. CANMET Material Technologies Laboratory (MTL) has developed a method to evaluate the warm sheet formability of standard magnesium alloys such as Mg AZ31 as well as new alloys as they are developed at CANMET-MTL and elsewhere. Finding and developing technologies for the protection of galvanic corrosion of magnesium alloys is also important. CANMET-MTL, in partnership with its stakeholders, has developed technologies to mitigate the surface corrosion of magnesium alloys.
- There is interest in using titanium for automotive applications due to its high strength, low density and excellent resistance to corrosion and oxidation. CANMET-MTL developed a metal powder injection moulding process to produce titanium alloys. The weight saving through direct replacement in existing automotive component designs or preferably in new designs using titanium would be about 50 percent.
- A feasibility study on adopting lightweight thermal structural panels for long-haul refrigeration trailers was completed. The results indicated that using the new panels could generate a 10 percent improvement in thermal efficiency and GHG emission reductions and that replacing the current floor panels with lightweight thermal panels could result in the greatest weight reduction.

For more information:
climri.nrcan.gc.ca/default_e.htm

Transportation Research and Development: **Fuel-Cell-Powered Mining Vehicles**

Objective: To develop the technology to replace diesel power with hydrogen fuel cell power in underground mining vehicles.

NRCan has taken a co-leadership role in the North American Consortium for Fuel-Cell-Powered Mining Vehicles. Hydrogen fuel cell power systems are more efficient in delivering power than conventional diesel equipment. Retrofitting diesel-powered vehicles with hydrogen fuel cells should improve vehicle productivity, operating costs and the work environment for underground miners by eliminating toxic underground diesel emissions and reducing heat and noise. Fuel cells have also been shown to have the potential to reduce CO_2 or GHG emissions by up to one million tonnes per year (26 percent of the total CO_2 equivalent emitted by mining extraction) and decrease operating costs by lowering mine ventilation needs.

Key 2005–2006 Achievements

- A major study on hydrogen production and delivery requirements for underground mining established the best methods for fuel cell mine vehicles and for underground Canadian mining operations.
- The development project on the fuel cell underground mine loader is now at the power-plant-testing stage; the vehicle integration stage and initial surface performance tests will follow.
- An agreement in principle was reached with Canada Economic Development and the Canadian Transportation Fuel Cell Alliance (NRCan) for initial funding to establish a hydrogen storage and delivery infrastructure and full-scale operational research at CANMET Mining and Mineral Sciences Laboratories' underground experimental mine in Val d'Or, Quebec. Also, significant project planning has been carried out with Canada Economic Development, Industry Canada and the hydrogen and mining industries to establish the ground-breaking mining Hydrogen Production and Delivery Research Consortium. It will carry out large-scale projects on hydrogen storage and utilization and the development of standards to facilitate full technology introduction, and support commercialization of Canadian technology into the Canadian and international mining industry.

For more information:
nrcan.gc.ca/mms/canmet-mtb/mmsl-lmsm/mines/mines-e.htm

Alternative Transportation Fuels: **Ethanol Expansion Program**

Objective: To expand fuel ethanol production and use in Canada.

The Ethanol Expansion Program, co-managed with Agriculture and Agri-Food Canada, is contributing to the construction costs of new fuel ethanol production facilities across Canada. Projects were selected through two rounds of competitive solicitation in 2004 and 2005 based on their ability to maximize ethanol production and reduce transportation GHG emissions. On average, program contributions account for less than 15 percent of the total plant construction costs, and contribution agreements contain repayment terms based on project profitability.

Key 2005–2006 Achievements

- As of June 2006, five new ethanol plants across the country had commenced construction, with four of these expected to be completed in 2006.
- These projects, for which private-sector investments total over half a billion dollars, plan a total capacity of over 600 million litres of ethanol per year, which will more than quadruple domestic production.
- When blended in gasoline, this additional ethanol will reduce life-cycle GHG emissions by an estimated 0.8 Mt per year.

For more information:
vehiclefuels.gc.ca

Alternative Transportation Fuels: Future Fuels Initiative

Objective: To increase Canada's fuel ethanol production and use in the transportation sector.

The Future Fuels Initiative, co-managed with Agriculture and Agri-Food Canada, targets motorists, provinces and territories, and industry stakeholders. The main activities are federal-provincial policy coordination, industry consultation, public awareness campaigns and analytical work on feedstocks, production costs, emissions and socio-economic impacts.

Key 2005–2006 Achievements

- Through the Council of Energy Ministers' Working Group on Renewable Fuels, joint federal-provincial-territorial analysis and consultations were conducted in support of the development of a national strategy for renewable fuels.
- Extensive consultations on renewable fuels policy and programs were conducted with industry stakeholders including agricultural producers, renewable fuel producers, fuel distributors and end-users, as well as environmental non-governmental organizations.
- Capabilities for life-cycle modelling of the energy and emission implications of traditional and alternative fuels were enhanced and extended.

For more information:
vehiclefuels.gc.ca

Alternative Transportation Fuels: Biodiesel Initiative

Objective: To support increased biodiesel production and use in Canada's transportation sector.

The Biodiesel Initiative supports the Government of Canada's proposed target of 500 million litres of biodiesel production per year by 2010. The main components of this initiative are research and development, technical and socio-economic studies, end-use demonstrations and testing, stakeholder education and standards development.

Key 2005–2006 Achievements

- Initiated a Canadian Biodiesel Distribution Infrastructure Roadmap to address the potential roadblocks and propose solutions and options to ensure the successful, sustainable growth of the Canadian biodiesel industry.
- Launched the Biofuels Quality Registry and the Proficiency Testing Program with the Alberta Research Council (www.biofuels.arc.ab.ca) to conduct fuel-quality testing of biodiesel samples, track fuel quality metrics to provide input for the development of an industry protocol and standard for fuel analysis, and evaluate the performance of laboratories on physical testing of biodiesel.
- Completed research to evaluate the technical and economic potential of possible feedstock sources, including extraction of corn oil during the fuel ethanol corn dry-milling process and conversion of the oil into biodiesel and/or other value-added products.

For more information:
vehiclefuels.gc.ca

Transportation Technologies: Canadian Transportation Fuel Cell Alliance

Objective: To demonstrate and evaluate various processes for producing hydrogen and delivering it to fuel cell vehicles at fuelling stations, to develop and demonstrate hydrogen-fuelled vehicles, and to participate in the development of codes and standards.

NRCan's Canadian Transportation Fuel Cell Alliance (CTFCA) is a private-public sector initiative involving technology developers, fuel providers, auto manufacturers, federal and provincial/territorial governments, academia and non-governmental organization representatives. The CTFCA contributes to a reduction in GHG emissions by encouraging advances in hydrogen and fuel cell technologies through demonstration projects that evaluate the technical, economic and environmental feasibility of different hydrogen fuelling options for fuel cell vehicles. The initiative also establishes a supporting framework for hydrogen fuelling by assisting in the development of codes and standards as well as certification and training programs.

Key 2005–2006 Achievements

- Completed the construction of three of the seven "Hydrogen Highway" fuelling stations in British Columbia and started construction of a fourth station. The five Ford Focus fuel cell cars successfully completed the first of three years of on-road testing and evaluation in the Vancouver and Victoria areas.
- Purolator Courier Ltd. took delivery of a hydrogen fuel-cell-powered delivery van in May 2005 and initiated a series of on-road performance tests that will be continued in the spring of 2006 in downtown Toronto. As well, a hydrogen fuelling station to serve the vehicle was installed at the Purolator depot in West Toronto.
- Prepared the new Canadian Hydrogen Installation Code, which will govern the installation of hydrogen-generating equipment, hydrogen-using equipment such as fuel cells, hydrogen-dispensing equipment, hydrogen storage containers, hydrogen-piping systems and related accessories.

For more information:
nrcan.gc.ca/es/etb/ctfca/index_e.html

Transportation Technologies: Hydrogen, Fuel Cells and Transportation Energy Program

Objective: In partnership with industry, to develop and deploy leading-edge hydrogen, fuel cell and transportation technologies that reduce GHG emissions, minimize other environmental impacts, increase the potential for job and economic growth, and extend the life span of Canada's energy resource base.

Program staff work with stakeholders in the domestic and international hydrogen and transportation industries, including original equipment manufacturers, industry associations, fleet managers, transit authorities, utilities, provincial and territorial governments, research organizations, universities, other federal departments, the U.S. Department of Energy and the International Energy Agency.

Highlights of the program's work include the following:

- Supporting Canadian industry in developing a world-class water electrolysis technology for the production of hydrogen from clean renewable energy sources.
- Working in partnership with Canada's fuel cell industry over the last 20 years and establishing Canada as a world leader in fuel cell and refuelling technologies. For example, the world's first hydrogen fuel cell bus was demonstrated in Canada.
- Supporting student vehicle challenges since the 1980s and bringing university and college students from across North America together with automotive manufacturers to modify existing vehicles to run on a variety of alternative fuels.
- Supporting the development of alternative transportation fuel technologies, for instance, for natural gas and propane vehicles, which has led to a new Canadian industry that is now exporting commercial products.

Key 2005–2006 Achievements

- Development of microstructured fuel cell with over 2500 hours operating time at 1 watt.
- Introduction of Canadian natural gas vehicle technology into India. The technology was developed under this program.
- Support for Challenge X competition, in conjunction with the U.S. Department of Energy and General Motors, to assist students in designing and implementing hybrid electric vehicle technologies. The University of Waterloo placed first in the June 2005 competition with its fuel cell vehicle design.

For more information:
nrcan.gc.ca/es/etb/cetc/cetc01/htmldocs/Groups/hyfate_e.htm

Chapter 7: Renewable Energy

Renewable Energy Use

In 2004, renewable energy generation capacity from renewable sources accounted for approximately 62 percent of total Canadian electricity capacity (see Table 7-2). Most of the renewable energy used in Canada comes from either hydro-electricity or thermal energy from biomass such as wood-waste sources.

Hydro-Electricity

Hydraulic power is a renewable energy based on the water cycle – evaporation, precipitation and flow of water toward the ocean. Canada has abundant water resources, and its geography provides many opportunities to produce low-cost energy. Tapping the energy from moving water has played an important role in the economic and social development of Canada for the past three centuries.

In 2004, hydro power accounted for about 59 percent of Canada's total electricity generation. Small-scale hydro-electric projects, with a capacity of 50 megawatts (MW) or less, constitute about 2.5 percent of Canada's electricity-generating capacity. Small-scale hydro has considerable potential for increased production.

Biomass

Bioenergy is a renewable source of energy derived from organic substances known as biomass. Biomass is supplied by agricultural wastes (such as chaff, straw, grain screenings, husks and shells, food-processing residues and methane) and forestry wastes (such as logging slash, sawdust, black liquor from the pulping process and other industrial waste). Other biomass supplies include animal litter and manure, dedicated feedstocks from agriculture and forest origin, landfill gas methane, urban wastes to be incinerated, and sewage for biogas. Bioenergy contributes about 6 percent of Canada's primary energy, mostly for industrial process heat, electricity generation and residential space heating. Corn and other agricultural products are also used to generate ethanol and biodiesels for the transportation market.

TABLE 7-1

Renewable Energy Markets and Technologies Used in Canada

Electricity	*Thermal Energy*
Hydro-electricity	Biomass (e.g. roundwood, pellets, wood chips)
Tidal power	Ground-source heat pumps (e.g. earth energy)
Biomass (e.g. wood waste)	Solar air-heating systems
Biogas (e.g. methane from landfill sites)	Solar hot water systems
Wind turbines	
Photovoltaic systems	
Mechanical Power	*Transportation*
Wind water pumps	Biodiesel
	Ethanol from biomass

TABLE 7-2

Electricity Generation Capacity From Renewable Sources (Includes Hydro)

Year	Renewable electricity generation capacity (megawatts)	Percent of total capacity
1990	59 557	58
1991	61 116	58
1992	62 895	58
1993	63 114	56
1994	63 175	56
1995	66 542	57
1996	67 101	59
1997	68 202	61
1998	68 340	62
1999	68 686	62
2000	69 005	62
2001	68 734	61
2002	70 895	62
2003	72 160	62
2004	72 783	62

Bioenergy production represents Canada's second largest renewable energy source. Most bioenergy is produced from organic refuse and used with the facilities in which the energy conversion takes place. The pulp and paper industry produces and uses most of Canada's bioenergy. Industrially produced heat and electricity, independent power producers' electricity, electricity from urban wastes and residential wood heat are all considered commonplace in Canada's energy mix.

Home heating with wood usually takes the form of stand-alone wood stoves, wood furnaces with hot-water or forced-air systems, fireplaces with advanced combustion inserts, high-efficiency fireplaces or high-thermal-mass masonry heaters. About 3 million Canadian households use wood for home heating. Canadians usually prefer roundwood, but alternatives include wood chips and pellets.

Earth Energy

As a result of the sun heating the surface of the planet, the temperature of the earth that is one or two metres below the surface remains fairly constant – between 5°C and 10°C. This is warmer than outside air during the winter and cooler than outside air in the middle of summer. A ground-source heat pump takes advantage of this temperature difference by using the earth or the ground water as a source of heat in the winter and as a "sink" for heat removed from indoor air in the summer. For this reason, ground-source heat pumps are known as earth energy systems (EESs).

During winter, EES installations remove heat from the earth using a liquid, typically an antifreeze solution, that circulates within an underground loop. It then upgrades the heat with a conventional heat pump and transfers it to indoor space or the water-heating system. During summer, the system reverses this process to operate as an air conditioner. EES installations supply less than 1 percent of the market for space and water heating and cooling in Canada.

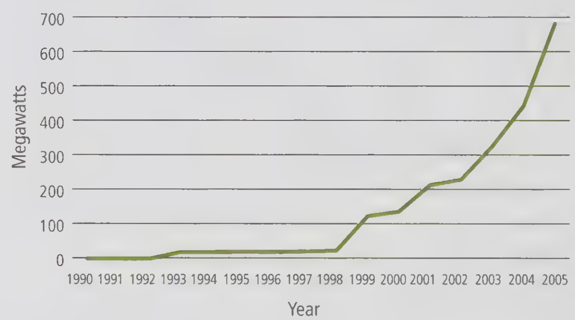
Wind Energy

Wind turbines convert the kinetic energy of wind into electrical or mechanical energy. Canada's land mass and coastal waters combine to provide a wind resource with extraordinary potential. While Canada has not achieved the level of wind generation seen in other countries, recent policy developments have spurred record growth in the Canadian wind generation industry (see Figure 7-1). In 2004, wind energy accounted for about 0.3 percent of Canada's total electricity generation, up from 0.2 percent in 2003. Despite significant additions in recent years, wind energy contributed only 0.4 percent of the total electrical generating capacity in Canada in 2004.

Wind energy also provides mechanical power. Several thousand wind-powered water pumps are used throughout Canada, mostly in the Prairie provinces. As well, Canadians use small, residential-sized wind turbines to power cottages and remote houses.

FIGURE 7-1

Canadian Wind Power Capacity, 1990 to 2005



Source: Canadian Wind Energy Association

Solar Energy

Three main technologies use energy from the sun:

- passive solar technologies – buildings are designed and located to maximize their reception of solar energy.
- active solar thermal systems – solar radiation is converted into thermal energy for heating air or water in residential, commercial and industrial applications.
- solar electric (photovoltaic) systems – solar radiation is used to produce electricity.

During the 1990s, Natural Resources Canada (NRCan) assisted a Canadian company in developing a perforated solar absorber to preheat ventilation air and reduce a building's fuel requirements for space heating. This technology is more cost-effective than conventional solar air-heating technologies and is gaining acceptance in Canada and abroad. Systems have been installed on industrial and commercial/institutional buildings throughout Canada.

Canada's total photovoltaic (PV) power installed capacity increased by 25 percent in 2005 to 17.6 MW from 14 MW at the end of 2004. Total PV module sales by Canada (domestic and export) were at 4.6 MW. The average market growth has been 25 percent annually since 1992. In 2005, jobs grew by 32 percent to 865 positions, with total revenues estimated at CAN$165 million, a 32 percent increase over 2004. Investments in research and development (R&D), manufacturing capacity, and acquisitions in PV-related business have not increased significantly over 2004, reaching a total of CAN$31 million, of which 30 percent were investments in R&D activities. The weighted average price of PV modules dropped to CAN$4.31 per watt in 2005, with a steady average decline of 12 percent per year since 1999. The total public (federal and provincial combined) R&D and demonstration budget reached CAN$6.7 million in 2005. Funding focused on technology and innovation with a 2025 horizon.

NRCan delivers several initiatives to increase the use of small-scale renewable energy in Canada. The following is the array of NRCan renewable energy programs.

Renewable Energy Programs: Wind Power Production Incentive (WPPI)

Objective: The WPPI is a 15-year, $260-million program to support the installation of 1000 MW of new wind energy capacity or the production of 2.6 terawatt hours by March 31, 2007.

The WPPI encourages electric utilities, independent power producers and other stakeholders to gain experience in wind power, an emerging energy source. The incentive is approximately $0.01 per kilowatt hour of production, and eligible recipients can receive the incentive on 10 years of production.

Key 2005–2006 Achievements

- Six new wind energy projects were commissioned in fiscal year 2005–2006: two are located in Ontario, two in Quebec, one in Saskatchewan and one in Manitoba. These projects contributed 436 MW of new wind energy capacity, and represent a total financial contribution over 10 years of more than $150 million.
- Since WPPI's introduction in 2002, about 670 MW of wind power capacity have been commissioned, representing 18 projects and a total financial commitment of $239 million.

For more information:
canren.gc.ca/wppi

Renewable Energy Programs: Initiative to Purchase Electricity From Emerging Renewable Energy Sources

Objective: To purchase electricity from emerging renewable energy sources (ERES) certified by a third party as having low environmental impact, with the objective of reducing greenhouse gas (GHG) and other air pollution emissions associated with federal electricity consumption.

Between 1998 and 2001, NRCan entered into three pilot projects to purchase electricity from ERES for federal facilities in Alberta, Prince Edward Island and Saskatchewan. The Government of Canada has pledged to purchase 20 percent of its electricity from ERES by 2010.

Key 2005–2006 Achievements

- About 90 gigawatt hours (GWh) of electricity from ERES were generated in Ontario through an agreement with Energy Ottawa.
- Also, 56 GWh of electricity from ERES continued to be generated for federal facilities in Alberta, Saskatchewan and Prince Edward Island, resulting in about 50 000 tonnes of GHG emissions reductions.
- Consultations took place in British Columbia, New Brunswick, Newfoundland and Labrador, and Nova Scotia.

For more information:
reed.nrcan.gc.ca

Renewable Energy Programs: Photovoltaic and Hybrid Systems Program

Objective: To support the development and application of solar PV technologies in Canada.

The program contributes to increasing the use of PV energy technologies in Canada by developing technologies and by facilitating the development of a Canadian-based globally competitive solar industry. It also contributes to the development of policies and programs. In collaboration with Canadian industry and universities as well as international energy research organizations, the program undertakes R&D activities and fosters information exchanges leading to the adoption of PV-hybrid systems that produce electricity from solar energy and another energy source; validates the performance and safety of utility-interactive inverter products; supports the development of building-integrated PV technologies and systems; and facilitates the development and adoption of harmonized standards and codes for PV systems in Canada.

Key 2005–2006 Achievements

- Collaborated with Concordia University on the development of a national research network on "solar buildings" that was approved in 2005. This will help build the scientific knowledge required to develop a zero-energy solar home and low-energy solar building optimizing daylighting, solar heat and solar electricity through an integrated design approach. The Solar Building Research Network now includes 10 universities and three government research centres.
- Partnered with PV manufacturers on projects that led to growth in the Canadian PV industry, employing over 900 people in 2005. These activities included R&D investments in the novel Spheral Solar Power Technology being developed by Automation Tooling System in Cambridge, Ontario, and novel power electronic products for PV-hybrid generation system being developed by XANTREX in Burnaby, British Columbia.

For more information:
cetc-varennes.nrcan.gc.ca/en/er_re.html

Renewable Energy Programs: Bioenergy Technology Program

Objective: To support efforts by Canadian industry to develop bioenergy technologies.

Technologies supported by this program include combustion, biochemical conversion of biomass to ethanol, thermochemical conversion of biomass to bio-oil and biogas, and biomass preparation and handling. Activities are directed toward improving the reliability and lowering the cost of technologies, disseminating information on technology feasibility and economics to potential users, and helping industry market its products in Canada and abroad.

Key 2005–2006 Achievements

- As the result of a major cost-shared project with NRCan, Iogen Corporation significantly improved the efficiency of the cellulose enzymes used in the company's process for producing fuel ethanol from cellulosic biomass. Iogen estimates that use of the more efficient enzymes will lower the cost of ethanol production from agricultural residues by 30 percent.
- NRCan supported the University of Toronto in developing an innovative technology to convert seed oils, waste grease, animal fats and tallow into high-quality biodiesel fuel. The technology uses mild reactor conditions to yield a superior biodiesel with significant reductions in capital and operational costs. BIOX Corporation of Oakville, Ontario, licensed the process and successfully operated a one-million-litres-per-year pilot demonstration plant. BIOX, with Sustainable Development Technology Canada support, is opening a 60-million-litres-per-year commercial demonstration plant.
- Through NRCan R&D support, Canadian biomass companies such as Ensyn, Enerkem and Nexterra are moving their technologies toward commercialization. As a result of this support, many of these companies have moved to the next level of commercialization and are now in various stages of commissioning. Ensyn is commissioning a 70-tonne-per-day biomass pyrolysis biorefinery in Renfrew, Ontario. Nexterra is working with Tolko Industries, a forest products company, to set up a gasification process that will use Tolko's forest residues to replace natural gas in lumber kilns. Enerkem has completed a technology assessment program with the City of Edmonton for a municipal solid waste gasification project.

Renewable Energy Programs: Renewable Energy Deployment Initiative (REDI)

Objective: To stimulate the demand for renewable energy systems by helping the supply industry in its marketing and infrastructure development efforts, including the provision of financial incentives.

REDI targets four systems: solar water heating, solar air heating and cooling, earth energy, and high-efficiency, low-emission biomass combustion. REDI promotes these systems in the business, federal and industrial markets through various means: a financial incentive, industry infrastructure development, a partnership with a utility coalition, market assessment, and information provision and awareness-raising activities.

Key 2005–2006 Achievements

- Experienced a record level of interest, completing 134 projects and receiving its 800th application (see Table 7-3). Published two important market documents: *The REDI Strategic Business Plan to March 2007* and *A Survey of Active-Solar Thermal Collectors, Industry and Markets in Canada*.
- Oversaw four solar domestic water-heating pilot projects in regions across Canada.
- Completed a successful $4-million, multi-year partnership with the Canadian Geo-Exchange Coalition to promote ground-source heat pumps in Canada.

For more information:
nrcan.gc.ca/redi

TABLE 7-3

REDI for Business Projects Completed, 1998 to 2005

Fiscal year	Number of projects completed	Estimated GHG reduction (tonnes CO_2/yr.)	Client investment	Federal incentive
1998	8	2 869.0	$1,306,295	$145,950
1999	9	260.8	$479,633	$119,910
2000	24	5 825.4	$1,849,918	$327,078
2001	43	21.7	$5,827,561	$1,197,965
2002	33	5 718.8	$2,745,834	$606,210
2003	89	39 653.5	$22,356,375	$2,551,845
2004	65	47 447.0	$11,200,942	$2,250,421
2005	134	34 060.3	$27,588,936	$4,014,779
Total	**405**	**135 856.5**	**$73,355,494**	**$11,214,158**

Renewable Energy Programs: Renewable Energy Technologies (RET) Program

Objective: To promote energy diversity and support efforts by Canadian industry to develop renewable energy technologies.

The Renewable Energy Technologies (RET) Program aims to improve the economics and efficiency of renewable energy technologies, including wind energy, small hydro (less than 20 MW), and thermal solar. It is actively involved in R&D to support the growth of the renewable energy industry in Canada. Growth will be achieved by:

- identifying and accelerating strategic R&D, development and deployment activities
- fostering the commercialization of new technologies
- identifying and developing opportunities for renewables integration
- developing infrastructure to support innovation, such as codes, policies and standards
- developing linkages between utilities, industry and academia
- conducting resource assessments
- supporting training and education
- disseminating results and findings
- supporting policy and programs
- engaging in international cooperation through the International Energy Agency

Key 2005–2006 Achievements

- Construction began in 2005 on the Drake Landing Solar Community, a 52-home subdivision in Okotoks, Alberta, south of Calgary. This seasonal solar thermal storage project, designed and led by CANMET Energy Technology Centre (CETC), will capture solar energy in the summer and store it for use in the winter. The solar district heating system will meet 90 percent of the community's residential space heating needs, a result unprecedented anywhere in the world. In November 2005, the project was awarded a Gold Award by the United Nations at the International Awards for Liveable Communities in Spain. It was also recognized as the Best New Idea of 2005 at the Annual Awards Gala held by the Calgary Home Builders Association.

- NRCan played a major role in establishing the Laval Hydro Turbine Industry Research Consortia in partnership with the Natural Sciences and Engineering Research Council of Canada, major Canadian hydro-turbine manufacturers and utilities. The facility is centred at the Laval University Hydraulic Machinery Laboratory (LAMH). The LAMH is a leading independent hydro turbine R&D facility in North America, and it has grown through the steady support of the RET Program. It will address the shortcomings in efforts to develop a strong Canadian R&D centre in the hydroelectric field by validating new, higher-efficiency hydro turbine designs.

- NRCan played a key role in the successful installation of the first-ever Wind-Diesel Integrated Control System (WDICS) on Ramea Island, Newfoundland and Labrador. The system consists of six 65-kilowatt wind turbines that will produce about 1 million kilowatt hours of electricity per year. The electricity will be fed to the local grid and will provide about 17 percent of Ramea's electrical load, while reducing carbon dioxide (CO_2) emissions by 750 tonnes per year. WDICS, a sophisticated control system for the integration of wind and diesel power generation, was developed with the support of CETC–Ottawa at the Atlantic Wind Test Site.

For more information:
canren.gc.ca

Renewable Energy Programs: Market Incentive Program (MIP)

Objective: The MIP was a $25-million program to stimulate emerging markets for renewable electricity.

Under the program, electric utilities, retailers and marketers submitted proposals for consideration by NRCan and Environment Canada for projects to develop market-based programs and promote the sale of electricity from emerging renewable sources, having low environmental impact, to residential and small-business customers. The Government of Canada provided a short-term financial incentive of up to 40 percent of the eligible costs of an approved project, to a maximum contribution of $5 million per recipient.

The program's CO_2 reduction objectives were 1.4 megatonnes per year by 2010.

Key 2005–2006 Achievements

- Agreement with SelectPower contributes to almost 1 million kilowatt hours of electricity from wind input into the Ontario energy supply, and information provided to consumers on small wind, solar and earth energy.
- TransAlta developed a Green Power Marketing Tool Kit for use by utilities and green power sellers.
- This program was completed on March 31, 2006, as per the original program framework.

For more information:
reed.nrcan.gc.ca

Renewable Energy Programs: Canadian Biomass Innovation Network (CBIN)

Objective: To develop sustainable and cost-effective technologies in bioenergy, biofuels, bioproducts and industrial bioprocesses for market acceptance, utilizing biomass resources in a sustainable and responsible way.

The Canadian Biomass Innovation Network (CBIN) supports strategic R&D in the areas of bioenergy, biofuels, bioproducts and industrial bioprocesses to displace Canada's fossil fuel energy consumption; directly or indirectly reduce GHG emissions; and seed the sustainable development of Canada's bio-based economy.

CBIN is a horizontal program developed and managed by five federal departments: Agriculture and Agri-Food Canada, Environment Canada, Industry Canada, National Research Council and Natural Resources Canada. The network coordinates and manages two federal government bio-based R&D initiatives:

- PERD "Bio-Based Energy Systems and Technologies" POL program
- Biotechnology R&D component of the new "Technology and Innovation (T&I)" Initiative

Key 2005–2006 Achievements

- In 2005, the Municipality of Boisbriand founded the CERVEAU (*Centre d'expérimentation et de recherche sur les végétaux pour l'environnement et l'aménagement urbain*), a non-profit organization dedicated to the development and the promotion of the use of fast-growing tree and shrub species for environmental ends. The municipality put forward public funds to acquire several hectares of land on its territory. This land was then changed from its original residential vocation to plantation sites.
- Optimization of operating parameters could lead to increased efficiency and reduced criteria emissions. Paprican has developed a boiler optimization protocol and, to test the protocol, has performed trials on 10 wood waste fired boilers for baseline testing and optimized 7 units with an average increase in steam from wood waste of over 20 percent with a dramatic decrease in CO_2 emissions and carbon in ash. The results have created great interest from many other facilities wishing to participate.
- Successful production of first-generation materials based on wheat and pea starches. Different families of blends with bio-based polylactic acid and polycaprolacone are fully biodegradable and offer a full range of properties depending on the starch and plasticizer content. A number of film, sheet and molded prototypes have been produced using conventional plastic processing equipment to demonstrate the feasibility and potential of these materials for the fabrication of consumer products.

For more information:
cbin.gc.ca

Chapter 8: Federal House in Order

Introduction

The Government of Canada is the country's largest single enterprise. It is working to get its house in order by setting a target of a 31 percent reduction in greenhouse gas (GHG) emissions from its own operations by 2010.

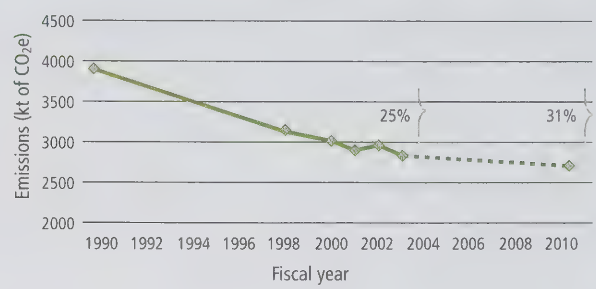
Since 1990, through building retrofits, better fleet management, strategic "green power" purchases and the downsizing of operations, the Government of Canada has already achieved a 25 percent emissions reduction. The Government of Canada will reduce its net emissions by a further 6 percent by 2010 (see Figure 8-1).

The Government of Canada will achieve its goal by additional building retrofits, fuel switching, improved fleet management, energy-efficient procurement and increased use of renewable energy within government operations. Moreover, the Government of Canada can help to "create the market" for certain new technologies on the verge of becoming viable. Key departments, which are responsible for 95 percent of government GHG emissions, have been assigned specific emission reduction targets and must report annually on their progress.

The task of target sharing entails assigning specific targets to the 11 largest emitting departments based on the emission-reduction opportunities identified within each organization. Natural Resources Canada (NRCan) is taking a lead role in managing this task and in providing programs and support to departments and agencies to help them achieve their targets. The leadership component of the Federal House in Order initiative encourages the reduction of all federal emissions by engaging the active participation of the departments, agencies and Crown corporations that were not designated with a target.

FIGURE 8-1

GHG Emissions Reductions From Federal Operations, 1990 to 2010



Federal Buildings Initiative (FBI)

Objective: To assist Government of Canada organizations to implement energy efficiency improvements, leading to reduced energy use, GHG emissions and operating costs.

The Federal Buildings Initiative (FBI) facilitates comprehensive energy efficiency upgrades and building retrofits for departments, agencies and Crown corporations of the Government of Canada. The FBI provides advice and consultation on project opportunities, model performance contracting documents, celebration and recognition opportunities, and a national network for energy management training. In facilitating public-private partnerships, the FBI manages a qualified list of energy management firms that provide a turnkey service to federal organizations, including project engineering and construction, third-party private sector financing, project monitoring, and employee training and awareness. FBI program officers work with federal organizations from project inception through to contract award and project monitoring and verification.

Key 2005–2006 Achievements

- Canadian Forces Base Halifax was awarded its second FBI energy efficiency project. Private sector investment of $12 million is expected to generate over $2 million annually in energy cost savings. The base's first project, implemented in 1995 with an investment of $11 million, has realized close to $2 million in energy savings each year.
- The private sector made new and incremental investments of $19.9 million in FBI projects.
- FBI energy efficiency projects awarded in 2005–2006 will reduce the federal government's annual utility bills by $3.1 million.

For more information:
oee.nrcan.gc.ca/fbi/home_page.cfm

Energy Technology Applications Group (ETAG)

Objective: To provide technical and project management services assisting federal facilities to implement energy reduction projects.

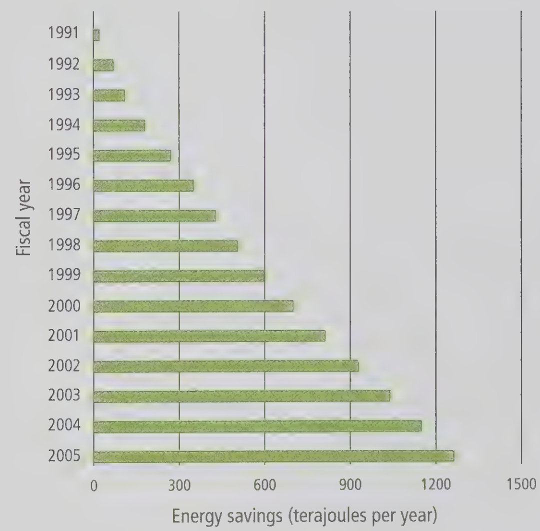
The experience gained by the Energy Technology Applications Group (ETAG) in building energy systems and access to the engineering and scientific network within NRCan ensures that environmentally responsible technologies are considered when federal government clients replace or modify their energy systems. ETAG used to be called the Federal Industrial Boiler Program but changed its name in 2004 to better reflect the range of energy technologies that it deals with and its role as technical support and liaison between federal facilities and the energy technology groups within CETC. Since its inception in 1991, it has worked with such departments as Agriculture and Agri-Food Canada (AAFC), Correctional Service Canada (CSC), Environment Canada, Foreign Affairs and International Trade Canada and the Department of National Defence to reduce their energy costs. Through projects implemented by ETAG, GHG emissions have been reduced by an average of 4.7 kilotonnes per year.

Key 2005–2006 Achievements

- Worked with CSC to continue its Federal House in Order-sponsored wind power projects. With the wind data accumulated over the past year, ETAG issued a feasability report; and as a result, CSC decided to proceed with purchasing and installing two 600-kilowatt turbines: one at Dorchester, New Brunswick, and another at Drumheller, Alberta. ETAG wrote the technical specifications and worked with the CSC project team to issue the request for proposal and evaluate the proposals received.
- CSC made a commitment in its 2003 Sustainable Development Strategy to reduce nitrogen oxide emissions in the Québec City-Windsor corridor and the Lower Fraser Valley by 10 percent from 2003 levels. ETAG has been working with CSC to develop an annual monitoring and boiler efficiency optimization program for the heating plants in these areas to meet that commitment. From the plant optimization, CSC will reduce its annual carbon dioxide (equivalent) emissions by 200 000 kilograms.
- ETAG worked with AAFC, providing technical and project assistance on a variety of sites and technologies. It performed a refit study of the heating and cooling plant at AAFC's research facility in Swift Current, Saskatchewan, identifying opportunities to save $100,000 and reduce carbon dioxide (equivalent) emissions by 600 000 kilograms per year. With ETAG's assistance, AAFC is moving ahead with installing a 50-kilowatt wind turbine at the Harrington research centre in Prince Edward Island. The project is expected to reduce annual carbon dioxide (equivalent) emissions by 43 000 kilograms.

FIGURE 8-2

Annual Energy Savings From Energy Technology Applications Group, 1991 to 2005



For more information:
etag-gate.ca

Federal Fleet Initiative (FFI)

Objective: To assist federal government departments to increase the energy efficiency of their fleets and reduce the environmental impact of federal vehicle operations and to promote the *Alternative Fuels Act* within the federal fleet.

The Federal Fleet Initiative (FFI) provides tools and information to federal fleet managers and drivers to help them respond to climate change and to improve the overall efficiency of their fleets. This program resides at Natural Resources Canada and is steered by an interdepartmental committee consisting of the 11 largest emitting federal departments. This committee meets on a regular basis to discuss fleet management and operational issues and activities. Treasury Board Secretariat, through the Motor Vehicle Policy, outlines new objectives and requirements of efficiency and environmental performance facing the federal fleet and the FFI assists departments in meeting these requirements.

Key 2005–2006 Achievements

- Increased the penetration of ethanol-85 (E85) fuel across the federal fleet by subsidizing 371 251 litres of E85 fuel to federal fleets (as of April 2005).
- Trained 1143 federal vehicle operators at workshops; trained an additional 1566 operators on-line. Assisted in purchasing 144 Leadership Vehicles (E85 and hybrid vehicles).
- Funded 11 demonstration projects – testing new technology applications across the federal fleet.

For more information:
oee.nrcan.gc.ca/communities-government/transportation/federal/mandate.cfm

FIGURE 8-3

Federal Fleet Size and Fuel Consumption, 1995 to 2004

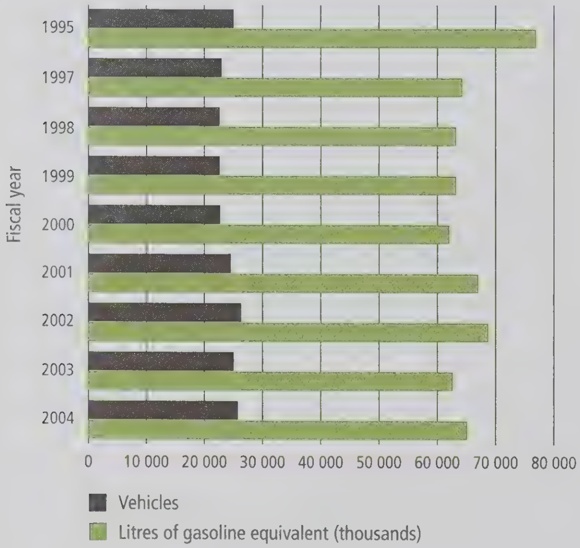
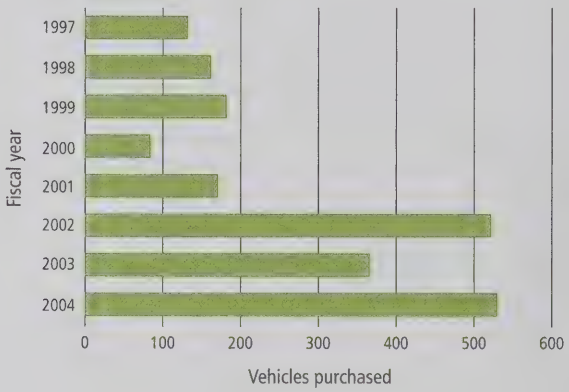


FIGURE 8-4

Purchases of Alternative Fuel Vehicles (Including Hybrids) for the Federal Fleet, 1997 to 2004



Chapter 9: General Programs

Outreach

Objective: To increase Canadians' awareness and understanding of climate change and the link to energy use, and to encourage Canadians to take action.

The Outreach program provides information and activities to encourage Canadians to integrate energy efficiency into their energy-use decisions. Outreach supplements program communications activities with publications, exhibits, joint projects and the Office of Energy Efficiency (OEE) Web site.

The Outreach program targets youth as future energy consumers by investing in joint initiatives in the education sector and through promotional projects. Public information activities increase awareness of the environmental impact of energy use. They also encourage consumers to adopt energy-efficient practices and to switch to alternative forms of energy.

The One-Tonne Challenge was launched in March 2004 as a component of the Outreach program. The Challenge was co-managed with Environment Canada, with input from and coordination with other departments such as Transport Canada. It was discontinued as of March 31, 2006.

Key 2005–2006 Achievements

- Distributed over 5.6 million energy efficiency publications and information tools, an increase of 27 percent over 2004–2005. OEE Web site visits were up almost 53 percent from 2004–2005.
- The on-line Energy and Environment Calendar Club continues to grow in popularity with more than 190 000 visits during 2005–2006, a 25 percent increase over the previous year.
- The 2005 One-Tonne Challenge Tracking Survey – Phase II found that over the year awareness of the One-Tonne Challenge jumped fourfold, from 15 percent to 60 percent of the adult population.

For more information:
oee.nrcan.gc.ca/corporate/programs.cfm#Outreach

RETScreen® International Clean Energy Decision Support Centre

Objective: To build the capacity of planners, decision-makers and industry to implement renewable energy and energy efficiency projects.

This objective is achieved by developing decision-making tools that reduce the cost of pre-feasibility studies, by disseminating knowledge to help people make better decisions, and by training people to better analyse the technical and financial viability of potential projects.

Key 2005–2006 Achievements

- Increased the number of users of the RETScreen International Clean Energy Project Analysis Software to more than 79 000 people in 213 countries. The number of people benefiting from this decision-support and capacity-building tool is growing at more than 400 new users every week. RETScreen is quickly becoming the de facto international standard for clean energy project pre-feasibility analysis.
- Released a number of new or improved RETScreen software and training tools, including a new multilingual version of the Combined Heat and Power software model and training course in 21 languages (including Chinese, Spanish, Russian and Hindi) covering roughly two thirds of the world's population.
- Initiated development of a major new version of the RETScreen Software. In RETScreen Version 4, the software's capabilities are being expanded from renewable energy, cogeneration and district energy to include a full array of financially viable clean power, heating and cooling technologies and energy efficiency measures. To enhance the software's international appeal, action is being taken in cooperation with NASA to increase the amount of climate data required by the tool to cover the entire surface of the planet, and the entire software suite is being translated into 21 languages.

For more information:
retscreen.net

Program of Energy Research and Development (PERD)

Objective: To fund research and development (R&D) designed to ensure a sustainable energy future for Canada in the best interests of our economy and our environment.

The PERD budget for 2005–2006 was approximately $57 million. Natural Resources Canada allocated $38.5 million to energy R&D programs managed and performed in the department, approximately 50 percent aimed at improving energy efficiency in Canada. Efficiencies are sought in energy production, distribution and end-use. Production encompasses both fossil fuels and alternative sources, including biomass.

Examples of funded projects are highlighted in the performance reporting in Chapters 3 to 7 of this document. The remaining $18.5 million has been allocated to 12 federal departments that are PERD partners.

For more information:
www2.nrcan.gc.ca/ES/OERD/english

Climate Change Technology Development and Innovation Program (of the *Government of Canada Action Plan 2000 on Climate Change*)

Objective: To accelerate the development of cost-effective R&D mitigation technologies in multiple sectors, building the intellectual foundation for long-term technological advances, building alliances and partnerships, and demonstrating federal leadership towards sustainable development.

The Climate Change Technology Development and Innovation Program received $20 million over six years (2001–2006).

Key 2005–2006 Achievements

- Published the *Clean Coal Technology Roadmap* and the *CO_2 Capture and Storage Technology Roadmap*. Technology roadmaps are designed to deliver a forecasting tool for determining future market needs, promoting cooperation, and planning the best approach to advancing promising climate change technologies.
- Novel Next Generation Technology Initiative completed the last request for proposals. This initiative sponsored basic research in climate change technologies at universities, federal laboratories and provincial laboratories. As of March 31, 2006, the initiative has sponsored 21 projects at universities across Canada and 34 projects in provincial and federal laboratories.

Canadian Initiative for International Technology Transfer (CIITT) (of the *Government of Canada Action Plan 2000 on Climate Change*)

Objective: To identify and develop technology transfer projects and facilitate the expansion of market opportunities for climate change technologies.

The Canadian Initiative for International Technology Transfer received $10 million over six years (2001–2006). The program has developed six initiatives to maximize international technology opportunities for Canada's small- and medium-sized enterprises through on-site technology promotion offices at Canadian embassies in Mexico, India and Poland (Poland covers six Eastern European countries), technology transfer feasibility studies by the private sector, workshops, missions and statistical monitoring of climate change technologies.

Key 2005–2006 Achievements

- Formal evaluation showed that 12 out of 22 feasibility studies funded are likely to proceed to implementation. This would result in $100 million in exports for Canada and reductions of over 500 000 tonnes of carbon dioxide.
- The Clean Energy Portal, created in 2003, actively promotes Canadian companies to foreign businesses, investors and governments through the Portal. The Portal uses Internet services and information technology advancements to enhance communication links and activity between individuals, institutes, industry and government stakeholders, which accelerates and promotes the commercialization and technology transfer of climate- and clean-energy-related technologies. The Clean Energy Portal averaged 61 223 hits per day from May 2005 to March 2006.

For more information:
cleanenergy.gc.ca

Climate Change Technology and Innovation Research and Development (T&I R&D Government of Canada Climate Change Plan – 2003)

Objective: To advance promising greenhouse gas (GHG) technologies through R&D, promote demonstration and early adoption initiatives to achieve long-term GHG reductions, and strengthen Canada's technology capacity.

Implemented in 2003 with $115 million in federal funding over five years, T&I R&D is based on long-term strategic planning that takes into account expected energy futures and visions to the year 2025. R&D is conducted in the five strategic areas of cleaner fossil fuels, advanced end-use efficiency technologies in buildings, transportation and industry, decentralized energy production (including renewables), biotechnology and the hydrogen economy.

The T&I R&D budget for 2005–2006 was $25 million. Natural Resources Canada (NRCan) allocated $18.5 million to energy R&D programs managed and performed in the department. Key NRCan R&D achievements contributing to improved energy efficiency in Canada are included in the performance reporting in Chapters 3 to 7. The remaining $6.5 million was allocated to eight federal departments that are T&I R&D partners.

Chapter 10: Cooperation

Introduction

This chapter describes Natural Resources Canada's (NRCan's) cooperation on efficiency and alternative energy (EAE) with the provinces and territories and internationally during the reporting period. Examples of program cooperation on specific EAE initiatives are given in the Key Achievements sections of earlier chapters. It should be noted that municipal governments and agencies participate in NRCan's EAE measures as clients (for training workshops, as recipients of financial incentives, etc.) and as partners (e.g. in anti-idling projects), and that NRCan also participates in ventures led by municipal organizations (e.g. Green Municipal Fund, as explained in the accompanying textbox) and provincially/territorially regulated electricity and provincially regulated natural gas utilities.

Green Municipal Fund

- The Green Municipal Fund was created in Budget 2000 by an endowment of $125 million to the Federation of Canadian Municipalities (FCM) in support of municipal government action to reduce greenhouse gases, cut pollution and improve the quality of life. The funds were doubled to $250 million in Budget 2001. In March 2005, a $300 million increase in FCM funding was approved, bringing the total up to $550 million. The funds were shared between NRCan and Environment Canada.
- The Government of Canada signed an agreement with the FCM, a non-profit organization, to deliver the Green Municipal Fund. Under the agreement, the Government of Canada (NRCan and Environment Canada) participates in governance of the fund, along with representatives from the public and private sectors, including municipal officials and technical experts, through a peer review committee and an advisory council. The FCM Board of Directors approves projects based on the council's recommendations.

There are several institutions in Canada that address energy efficiency issues in broad terms, including the three data and analysis centres established by NRCan, the host universities and other partners. These centres are also sponsored by other federal departments, provincial government agencies and various associations and energy supply utilities. They facilitate access to data on energy use in the industry, transportation and building sectors, monitor the quality of data, and investigate methods to improve data collection and analysis. The goal of another institution, the Canadian Centre for Energy Information, is to engage North Americans in critical inquiry and enlightened discussion on energy and energy-related issues affecting their quality of life. A third institution, the Canadian Energy Efficiency Alliance, is a non-profit organization established to promote the efficient use of energy in Canada.

There are three national consultative bodies in the area of energy efficiency:

- ADM Steering Committee on Energy Efficiency (ASCEE), established under the Council of Energy Ministers;
- Demand Side Management Working Group (DSM WG); and
- Office of Energy Efficiency (OEE) National Advisory Council on Energy Efficiency (NACEE).

In 2004, federal, provincial and territorial energy ministers decided that the ASCEE should be formed and tasked with establishing a coordinated and complementary agenda for energy efficiency in the built environment, industry and transportation sectors. The ASCEE held five meetings in 2005–2006 with representatives of the federal government, eight provinces, industry, and environmental non-governmental organizations.

The previously existing DSM WG is now under the auspices of the ASCEE. It began its work in 2003 and its members represent NRCan, industry and seven provinces and territories. The DSM WG undertook joint work and completed various studies related to demand side management, including the identification of the

DSM potential, regulatory process and framework. The DSM WG also created an "Energy Code Collaborative" to oversee work on energy codes for buildings and houses, produced an inventory of energy efficiency programs for low-income households, and fostered cooperation between jurisdictions in this area.

The ASCEE sponsored the formation of a federal/provincial working group on transportation energy in 2005 to seek opportunities for stronger cooperation among governments in harmonizing policies and programs that can impact energy efficiency and to make recommendations to ministers on the need for government action. The Transportation Working Group on Energy Efficiency (TWGEE) comprises senior federal and provincial government officials. Members come from a variety of departments (primarily energy and transportation), representing the interdisciplinary nature of the transportation energy efficiency issue. The primary role of TWGEE is to guide discussions and work toward a long-term, integrated approach to accelerating transportation energy efficiency nationally.

NRCan created NACEE in April 1998 to advise and guide the OEE on the most effective way to achieve its mission. Its membership is drawn from across Canada and all economic sectors and includes provincial/territorial officials and representatives of electricity and natural gas utilities, who have the opportunity to comment on the OEE's business plan and programs. NACEE met three times during 2005–2006.

Federal-Provincial and Federal-Territorial Cooperation

Recently there has been renewed interest in increased energy efficiency as a means of maximizing service from the existing energy supply capacity in the country. Provincial and territorial governments helped to deliver a substantial number of EAE programs during the reporting period to reduce energy costs, increase competitiveness, improve air quality and generate economic opportunities. Coordination between the federal and provincial/territorial levels is essential to avoid duplication and ensure efficient program delivery. During the reporting period, governments cooperated on energy efficiency in general and on specific program initiatives.

All provinces and territories engage in energy efficiency activities and/or deliver programs in their respective jurisdictions. In some provinces and territories, specific organizations are mandated to promote energy efficiency. For example, Energy Solutions Alberta, under Climate Change Central, is a focus for information and action on energy efficiency and conservation in Alberta. In Saskatchewan, the Office of Energy Conservation's mandate is to encourage and support voluntary action by the public and by industry through public information, energy efficiency demonstrations, and the development of pilot projects. The Ontario Power Authority recently established the Conservation Bureau with a mandate to provide leadership in planning and coordinating measures for electricity conservation and load management. The Energy Efficiency and Conservation Agency of New Brunswick was created in late 2005 to influence efficient energy use, help control energy expenses and lessen the impact of energy use on the environment. The Canada-Yukon Energy Solutions Centre is a service and program delivery agency for federal and Yukon government programs on energy efficiency and green power. The Arctic Energy Alliance promotes energy efficiency and renewable energy in the Northwest Territories. The Nunavut Energy Centre promotes energy efficiency and renewable energy in Nunavut.

Cooperation Agreements

NRCan's Letter of Cooperation (LOC) on EAE with the Agence de l'efficacité énergétique du Québec provides for efficient consultation and exchange of information between the two governments, coordination of EAE activities in Quebec, and creation of opportunities for joint projects. The management committee established under the LOC met during the year to review policy and program developments, progress on joint program initiatives, and areas for further cooperation. The LOC played a considerable role in facilitating three activities in particular:

- management of the licensing agreement for delivery of EnerGuide for Houses
- the processing of projects submitted to the Energy Innovators Initiative and the Commercial Building Incentive Program by public organizations in Quebec; this cooperation framework is also being applied to other NRCan programs targeting the Quebec public sector
- management of an agreement relating to the Programme d'intervention en réfrigération dans les arénas du Québec, under which NRCan has provided technical support for the implementation of innovative refrigeration systems in Quebec's ice rinks

NRCan's LOC on energy efficiency and renewable energy with the Government of Yukon facilitates information exchange and the creation of opportunities for joint projects in the Yukon, including the establishment of the Canada-Yukon Energy Solutions Centre in Whitehorse. The centre provides access to relevant technical services and programs for the Yukon population and undertakes outreach and public education activities.

The Government of Canada contributes to the Arctic Energy Alliance to promote energy efficiency and renewable energy in the Northwest Territories and provide opportunities for EAE projects. The Alliance is also the delivery agent in the Northwest Territories for R-2000. Through the contribution agreement with the Qulliq Energy Corporation, the Government of Canada contributes to the Nunavut Energy Centre, which promotes energy efficiency and renewable energy in Nunavut.

The Government of Canada promotes energy efficiency and renewable energy in Alberta by working with Climate Change Central, a non-profit corporation funded by a multi-stakeholder base, including the Government of Alberta.

International Cooperation

NRCan cooperates with several international organizations and foreign governments in EAE program areas. Canada benefits from this cooperation:

- by learning about improved ways of designing and delivering EAE programs to meet policy objectives
- through working with others on the harmonization of energy efficiency tests and performance standards to reduce barriers to trade in energy-using products

International Energy Agency (IEA)

The IEA, based in Paris, is an autonomous agency of the Organization for Economic Co-operation and Development. The IEA carries out a comprehensive program of energy cooperation among its 26 member countries, including Canada. IEA member governments have committed to sharing energy information, coordinating energy policies and cooperating in the development of rational energy programs. The IEA and its governing board are assisted in their work by several standing groups and special committees, which bring together energy specialists from member countries.

The Standing Group on Long-Term Co-operation (SLT) is the key committee on the policy side. It analyses policies to promote conservation and the efficient use of energy, the increased use of alternatives to oil, and other measures to increase long-term energy security while protecting the environment. The SLT monitors energy developments in member countries and makes recommendations on energy policy through a regular series of individual country reviews. The Energy Efficiency Working Party (EEWP) of the SLT undertakes IEA work on specific issues related to energy efficiency. The OEE represents Canada on the EEWP.

Canada's international energy research and development objectives are advanced primarily through the IEA's Working Parties and the Committee on Energy Research and Technology, chaired by NRCan. Canada is a signatory to 31 of the IEA's 40 implementing agreements for research and development (R&D) cooperation programs.

NRCan is a member of the Centre for the Analysis and Dissemination of Demonstrated Energy Technologies (CADDET), established under the IEA Agreement on Energy and Environmental Technologies Information Centres. CADDET, an international information network, helps managers, engineers, architects and researchers find out about energy-using technologies that have worked in other countries.

Canada also cooperates with research centres in member countries on several agreements and programs on R&D and technology. NRCan facilitates R&D and commercial business ventures abroad by Canadian firms by undertaking a wide variety of activities, including participating in various IEA tasks and supporting technical and trade-oriented workshops and conferences.

United Nations

RETScreen® International is managed under the leadership of NRCan's CANMET Energy Technology Centre–Varennes (CETC–Varennes) through cost- and task-shared collaborative ventures with other governments and multilateral organizations, and with technical

support from more than 200 experts representing industry, government and academia. Key partners are the Energy Unit of the United Nations Environment Program (UNEP) and the UNEP-Global Environment Facility-sponsored Solar and Wind Energy Resource Assessment (SWERA) project. Other key international partners include NASA's Langley Research Center and the World Bank's Prototype Carbon Fund.

China

In February 2001, Canada and China signed a Memorandum of Understanding (MOU) on Energy Cooperation. In January 2003, they signed an MOU on Climate Change and the Clean Development Mechanism. Energy efficiency is among the areas of cooperation identified in both MOUs.

Mexico

NRCan signed an MOU on EAE cooperation with the Mexican Energy Secretariat in June 1996. Its objective is to contribute to the EAE objectives of Canada and Mexico by improving the design and delivery of EAE programs and enhancing trade and investment as well as technical and other exchanges related to energy-efficient products, energy management services and alternative energy goods and services.

Under the MOU on EAE, officials of Mexico's National Commission for Energy Savings (CONAE) participated in an industrial energy efficiency conference held in May 2005 in Ottawa. Also under the MOU, NRCan organized an energy efficiency workshop in cooperation with CONAE in Puebla City, Mexico. The workshop was held in March 2006.

United States

NRCan and the U.S. Department of Energy (DOE) have an MOU on road transportation, energy efficiency and alternative fuels. It provides a formal mechanism for negotiating and harmonizing North American policy on fuel efficiency, fuel quality and alternative transportation fuels. The MOU provides a framework for joint projects and studies in areas of mutual interest, such as the costs and market potential of hybrid electric-powered and diesel-powered vehicles. The MOU facilitates bilateral discussion of a broad range of issues in the motor vehicle and fuels policy area and affords access to technology assessments and policy-related studies conducted for the DOE by its national laboratories.

Canada has been cooperating with the U.S. DOE under an MOU on energy R&D in the areas of fuel cells, fossil fuels, bioenergy, community systems and microgeneration, nuclear fission, and carbon sequestration.

United States and Mexico

NRCan continues to participate with the United States and Mexico in the Energy Efficiency Experts Group of the North American Energy Working Group (NAEWG) to promote the harmonization of energy efficiency test methods, mutual recognition of conformity assessment systems for energy efficiency standards, and cooperation on trilateral energy efficiency labelling programs. In 2005–2006, work under NAEWG primarily involved coordinating the energy sector commitment to the Security and Prosperity Initiative. In addition to ongoing standards and program collaboration, a project has been implemented to develop a North American approach to standby loss by electricity-using products.

Also under the umbrella of the NAEWG, Canada, the United States and Mexico have been charged with implementing an initiative that will contribute to accelerating the adoption of affordable and appropriate sustainable housing solutions for rapidly growing regions of Mexico. In early 2004, NRCan's CANMET Energy Technology Centre (CETC) was given the lead role within the NAEWG Science and Technology Experts Group for a sustainable housing project in Mexico known as La Casa Nueva / La Comunidad Nueva (LCN).

A Canada-Mexico Partnership (CMP) was established in October 2004. The CMP is designed to be a high-level public-private sector alliance identifying policies for facilitating cooperation, enhancing investment and creating opportunities for Canadian entrepreneurs to take part in projects that contribute to the socio-economic development of Mexican society.

Three themes were identified as priorities under the CMP:

- Housing and Urban Development
- Competitiveness
- Human Capital

The Housing and Urban Development theme is being led by two agencies: Canada Mortgage and Housing Corporation (CMHC) for issues related to housing; and Industry Canada's Sustainable Cities Initiative, for issues related to urban development. Mexico identified a number of activities related to housing technology, energy efficiency, renewable energy and sustainable communities as areas of interest. As a result of CETC's previous and ongoing technology cooperation activities in Mexico under the NAEWG-LCN initiative, CMHC invited the centre to help develop the terms of reference for housing technology activities under the CMP and asked for its involvement and technical input in furthering specific activities of the CMP housing technology working group.

At the same time, Industry Canada's Sustainable Cities Initiative is undertaking a number of targeted projects in the cities of Matamoros and Reynosa, Mexico, to foster sustainable solutions to many of the energy and environmental pressures facing most Mexican cities. These activities are being brought under the umbrella of the CMP. Sustainable and energy-efficient housing is one of the priority areas identified under the Sustainable Cities Initiative. NRCan's CETC has been invited to assist and manage the implementation of the sustainable housing components of the Sustainable Cities Initiative, leveraging and providing a bridge between the CMP housing technology working group and the NAEWG-LCN.

Appendix 1: NRCan's Efficiency and Alternative Energy Initiatives and Expenditures, 2005–2006

	(millions of dollars)
Energy Efficiency – Equipment	**$16.5**
Energy Efficiency Standards and Regulations	
Equipment Labelling and Promotion	
EnerGuide for Industry	
Mine Ventilation	
Energy Efficiency – Housing and Buildings[1]	**$107.4**
R-2000 Standard and EnerGuide for (New) Houses	
Housing Energy Technology Program	
Super E™ House Program	
EnerGuide for Houses and Retrofit Incentives	
Commercial Building Incentive Program	
Industrial Building Incentive Program	
Green Buildings Program	
EnerGuide for Existing Buildings	
Refrigeration Action Program for Buildings	
Buildings Program – Intelligent Buildings	
Building Energy Simulation Program	
Distributed Energy Program	
Integrated Energy Systems Laboratory	
Communities and Neighbourhoods Program	
Federal Buildings Initiative	
Energy Technology Applications Group	
Energy Efficiency – Industry	**$34.3**
Industrial Energy Efficiency (Canadian Industry Program for Energy Conservation; Industrial Energy Innovators)	
Clean Electric Power Generation	
Processing and Environmental Catalysis Program	
Industrial System Optimization Program	
Industry Energy Research and Development Program	
Emerging Technologies Program	
Industrial Energy Innovation	
Minerals and Metals Program	

	(millions of dollars)
Energy Efficiency – Transportation	**$21.5**
Vehicle Efficiency	
EnerGuide for Vehicles	
Personal Vehicles	
Fleet Vehicles	
Canadian Lightweight Materials Research Initiative	
Federal Fleet Initiative	
Alternative Energy – Transportation	**$49.8**
Fuel-Cell-Powered Mining Vehicles	
Ethanol Expansion Program	
Future Fuels Initiative	
Biodiesel Initiative	
Canadian Transportation Fuel Cell Alliance	
Hydrogen, Fuel Cells and Transportation Energy Program	
Alternative Energy – Renewable Energy Sources	**$43.3**
Wind Power Production Incentive	
Initiative to Purchase Electricity From Emerging Renewable Energy Sources	
Photovoltaic and Hybrid Systems Program	
Bioenergy Technology Program	
Renewable Energy Deployment Initiative	
Renewable Energy Technologies Program	
Market Incentive Program	
Canadian Biomass Innovation Network	
General Programs[2]	**$16.4**
Outreach	
RETScreen® International Clean Energy Decision Support Centre	
National Energy Use Database	
Total	**$289.2**

[1] In addition to the resources cited here, $150 million was provided to the Green Municipal Fund that is managed by the Federation of Canadian Municipalities.

[2] Totals allocated for funding programs in Chapter 9 are reflected in the relevant program entries.

Appendix 2: Data Presented in Report

The aggregate energy use data presented in this report are taken from Statistics Canada's *Report on Energy Supply-Demand in Canada* (RESD). Differences exist between this report and *Canada's Emissions Outlook: An Update* (CEO Update) concerning the sector allocations of RESD energy use data. The CEO Update's sector allocation is based on Environment Canada's *Trends in Canada's Greenhouse Gas Emissions 1990–1997*, whereas this report uses a definition better suited for the purpose of energy end-use analysis. Some modifications to the original Statistics Canada data were required and are documented in Appendix A of Natural Resources Canada's *Energy Use Data Handbook, 1990 and 1997 to 2004*.

FIGURE 1-1: Energy Intensity and the Energy Efficiency Effect, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Energy intensity index	1.00	1.00	1.00	1.00	0.99	0.98	1.00	0.96	0.91	0.89	0.87	0.84	0.84	0.85	0.83
Index of energy efficiency effect	1.00	0.99	0.98	0.95	0.94	0.92	0.93	0.91	0.89	0.88	0.88	0.87	0.87	0.88	0.86

FIGURE 1-2: Secondary Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Estimated energy use without energy efficiency improvements	1.00	0.99	1.02	1.06	1.11	1.15	1.18	1.20	1.19	1.24	1.28	1.26	1.31	1.33	1.36
Actual energy use	1.00	0.98	1.00	1.01	1.05	1.07	1.11	1.11	1.09	1.12	1.16	1.14	1.18	1.21	1.23

FIGURE 1-3: Electricity Production From Non-Hydro Renewable Sources, 1991 to 2003

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
GWh	3649	4134	4477	5362	5422	5855	6419	6599	7372	7418	7512	10 430	11 030

FIGURE 2-1: Volume of Monthly Import Documents

	Paper	Electronic
Apr-05	6 745	36 064
May-05	5 207	39 447
Jun-05	5 221	44 106
Jul-05	4 845	41 303
Aug-05	4 731	46 648
Sep-05	3 778	45 142
Oct-05	4 296	46 773
Nov-05	5 175	43 475
Dec-05	5 121	40 821
Jan-06	5 378	40 034
Feb-06	5 742	38 653
Mar-06	7 574	43 829
Total	**63 813**	**506 295**

FIGURE 2-4: ENERGY STAR Qualified Appliances as a Percentage of Total Category Sales in Canada, 1999 to 2004

Appliance	1999	2000	2001	2002	2003	2004
Dishwashers	0.56	1.57	9.66	29.77	56.50	80.95
Refrigerators	–	–	11.40	22.26	40.68	34.16
Washers	1.93	2.24	9.24	22.07	30.55	36.16

FIGURE 2-5: ENERGY STAR Awareness Levels in Canada, 2005

	Percent
Aware – non-aided	36
Aware – aided	80

FIGURE 3-1: Canadian Households by Type of Dwelling, 2004

	Number of households	Percentage
Single detached	7 030 118	57
Apartments	3 823 562	31
Single attached	1 270 266	10
Mobile homes	250 684	2
Total	**12 374 630**	**100**

FIGURE 3-2: Residential Energy Use by Purpose, 2004

	Energy use (petajoules)	Percentage
Space heating	811.1	57
Water heating	347.7	24
Appliances	185.5	13
Lighting	63.8	5
Space cooling	12.7	1
Total	**1420.8**	**100**

FIGURE 3-3: Residential Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Estimated energy use without energy efficiency improvements	1.00	1.04	1.10	1.14	1.14	1.17	1.22	1.21	1.13	1.17	1.24	1.21	1.27	1.31	1.31
Actual energy use	1.00	0.98	1.01	1.04	1.07	1.05	1.13	1.08	0.98	1.03	1.08	1.04	1.08	1.12	1.10

FIGURE 3-4: Annual Heating Consumption for Houses Constructed to Different Standards

Description	Annual heating consumption (GJ)
Typical existing house (1970)	216.812
Typical new house (2002)	146.274
Model National Energy Code house (2002)	112.101
R-2000 house	78.747

FIGURE 3-5: Average Energy Consumption per Household, Pre-1946 to 2001–2006 Construction

Year built	Average energy consumption (GJ)	EGH rating
Pre-1946	296	44
1946–1960	222	56
1961–1970	210	60
1971–1980	199	62
1981–1990	191	65
1991–2000	170	69
2001–2006	159	72
All EGH in Canada	220	58
R-2000	100	82

FIGURE 3-6: Average Energy Consumption* of New Appliances, 1990 and 2004 Models

	1990	2004
Clothes washers	1218	573
Clothes dryers	1103	912
Dishwashers	1026	457
Refrigerators	956	478
Electric ranges	772	653
Freezers	714	373

*kWh/yr.

FIGURE 3-7: Number of Eligible R-2000 Housing Starts, 1990 to 2005

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of eligible R-2000 housing starts	495	699	1196	1299	784	610	416	484	265	213	319	329	428	379	582	478

FIGURE 3-8: National Trends in Air Leakage in Houses, Pre-1945 to 2000–2006 Construction

Year built	Average air change at 50 Pa First EGH evaluation (A)	Post-retrofit evaluation (B)	R-2000
Pre-1945	11	8	n.a.
1945–1959	8	6	n.a.
1960–1969	6	5	n.a.
1970–1979	6	5	n.a.
1980–1989	5	4	0.9
1990–1999	4	4	1.1
2000–2006	4	3	1.1
Average	7	6	1.1

FIGURE 3-9: Evaluations Under EnerGuide for Houses, 1998 to 2005

Fiscal year of EGH evaluation	1998	1999	2000	2001	2002	2003	2004	2005
House evaluated but not re-evaluated (A evaluation)	3672	9106	11 509	11 087	16 561	48 250	58 742	79 380
Houses retrofitted and re-evaluated (B evaluation)	832	225	607	709	1 144	2 718	18 076	31 878

FIGURE 3-10: Residential Energy Use and Energy Savings per Household, Pre-1945 to 2000–2006

	Pre-1945	1945–1959	1960–1969	1970–1979	1980–1989	1990–1999	2000–2006	Average
Energy use pre-evaluation (GJ)	301	229	219	209	203	188	170	230
Evaluation-identified energy savings (GJ)	139	96	88	79	66	53	41	92
Actual energy savings after renovations (GJ)	99	66	59	54	48	47	44	64

FIGURE 4-1: Commercial/Institutional Energy Use by Activity Type, 2004

	Energy use (petajoules)	Percentage
Offices	383.6	33
Educational services	183.5	16
Health care and social assistance	151.7	13
Retail trade	142.1	12
Accommodation and food services	89.5	8
Wholesale trade	53.8	5
Transportation and warehousing	52.0	4
Information and cultural industries	42.8	4
Arts, entertainment and recreation	38.5	3
Other services	25.7	2
Total	**1163.2**	**100**

FIGURE 4-2: Commercial/Institutional Energy Use by Purpose, 2004

End use	Energy use (petajoules)	Percentage
Space heating	614.18	53
Auxiliary equipment	165.39	14
Lighting	114.99	10
Water heating	102.71	9
Auxiliary motors	97.26	8
Space cooling	68.76	6
Total	**1163.28**	**100**

FIGURE 4-3: Commercial/Institutional Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Estimated energy use without energy efficiency improvements	1.00	1.05	1.08	1.13	1.13	1.16	1.19	1.19	1.15	1.21	1.25	1.25	1.33	1.35	1.35
Actual energy use	1.00	1.03	1.04	1.08	1.07	1.11	1.13	1.15	1.09	1.13	1.24	1.22	1.31	1.35	1.35

FIGURE 4-4: Energy Use in Commercial Buildings, 2005

	Gigajoules per m^2 per year
CBIP results (1998–2005)	1.05
Model National Energy Code for Buildings (MNECB)	1.61
All commercial buildings (CICES)	1.48

FIGURE 4-5: Estimated Average Energy Savings by Type of Building Under the Commercial Building Incentive Program, 2005

Building type	Average energy savings (GJ/year)
Health care	5098
Retail	4712
Multi-unit residential building	3904
Education	3734
Retail food sector	3640
Other	3621
Industrial	3101
Office	2333

FIGURE 5-1: Industrial Energy Use by Sub-Sector – Including Electricity Related Emissions, 2004

	Percent of industrial energy use (%)
Pulp and paper	26.7
Mining	19.4
Other manufacturing	17.7
Petroleum refining	10.4
Smelting and refining	7.6
Iron and steel	7.6
Chemicals	6.2
Cement	2.0
Construction	1.8
Forestry	0.7
Total	**100.0**

FIGURE 5-2: Cost of Energy to Manufacturing Industries as a Percentage of Total Production Cost, 2004

Industry	Energy cost / total production cost (%)
Cement	38.70
Aluminum	17.13
Pulp and paper	14.27
Iron and steel	13.06
Chemicals	11.48
Petroleum refining	2.36
Transportation equipment and manufacturing	0.84

FIGURE 5-3: Industrial Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Estimated energy use without energy efficiency improvements	1.00	1.14	1.15	1.18	1.17	1.24	1.29	1.24	1.28	1.30	1.32
Actual energy use	1.00	1.07	1.10	1.10	1.08	1.11	1.15	1.10	1.16	1.20	1.21

FIGURE 5-4: CIPEC Energy Intensity Index, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Energy intensity index	1.00	1.05	1.08	1.06	1.06	1.04	1.03	0.98	0.96	0.95	0.91	0.92	0.91	0.93	0.91

FIGURE 5-5: Estimated CIPEC Energy Savings, 2001 to 2005

Energy savings	2001	2002	2003	2004	2005
Program total (petajoules)	2.33	5.01	8.34	12.06	13.52

FIGURE 5-6: Industrial Dollars to $ense Participants, 1997 to 2005

	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of industrial workshop participants	98	132	167	260	410	421	490	1001	1051

FIGURE 6-1: Transportation Energy Use by Mode, 2004

	Energy use (petajoules)	Percentage
Passenger light vehicle	1046.6	42.5
Freight truck	833.5	33.8
Passenger aviation	234.1	9.5
Freight marine	114.2	4.6
Off-road	95.7	3.9
Freight rail	72.5	2.9
Passenger bus	51.0	2.1
Freight aviation	15.0	0.6
Passenger rail	2.6	0.1
Total	**2465.1**	**100.0**

FIGURE 6-2: Transportation Energy Use, Actual and Without Energy Efficiency Improvements, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Estimated energy use without energy efficiency improvements	1.00	0.98	1.01	1.06	1.13	1.16	1.18	1.23	1.27	1.32	1.34	1.34	1.39	1.42	1.48
Actual energy use	1.00	0.96	0.99	1.00	1.05	1.07	1.09	1.13	1.17	1.20	1.22	1.21	1.23	1.26	1.31

FIGURE 6-3: Market Shares of New Passenger Car and Light Truck Sales, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Passenger car market share (%)	74.7	75.2	72.7	69.7	67.2	65.1	62.8	59.8	59.1	60.9	63.0	63.4	62.7	62.2	61.7
Passenger light truck market share (%)	25.3	24.8	27.3	30.3	32.8	34.9	37.2	40.2	40.9	39.1	37.0	36.6	37.3	37.8	38.3

FIGURE 6-4: New Car Fuel Efficiency, Normalized for Weight and Power, 1990 to 2003

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
L/100 km	1.00	0.98	0.99	0.99	1.00	0.96	0.96	0.98	0.96	0.96	0.95	0.95	0.94	0.93
L/100 km/kg	1.00	1.00	1.01	0.99	0.96	0.91	0.92	0.93	0.92	0.91	0.90	0.89	0.87	0.86
L/100 km/hp	1.00	0.98	0.95	0.93	0.91	0.85	0.82	0.82	0.79	0.79	0.76	0.75	0.73	0.71

FIGURE 6-5: Average Activity per Truck (tonne kilometres/truck), 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Medium- and heavy-duty truck vehicle activity	106 043	98 293	101 971	114 639	133 970	143 129	141 053	163 972	162 918	174 813	178 340	197 788	198 401	201 338	212 776

FIGURE 6-6: Trucking Energy Intensity, 1990 to 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Medium- and heavy-duty truck energy intensity	3.94	4.07	4.04	3.84	3.57	3.61	3.51	3.45	3.30	3.10	3.13	2.92	2.93	3.01	2.99

FIGURE 6-7: Company Average Fuel Consumption (CAFC) vs. Canadian Voluntary Standards, 1990 to 2005

Model year	Truck standard (11.4 L/100 km)	Trucks CAFC	Car standard (8.6 L/100 km)	Cars CAFC
1990	11.8	11.4	8.6	8.2
1991	11.6	11.1	8.6	8.0
1992	11.6	11.3	8.6	8.1
1993	11.5	11.1	8.6	8.1
1994	11.5	11.5	8.6	8.2
1995	11.4	11.5	8.6	7.9
1996	11.4	11.3	8.6	7.9
1997	11.4	11.3	8.6	8.0
1998	11.4	11.3	8.6	7.9
1999	11.4	11.3	8.6	7.9
2000	11.4	11.1	8.6	7.8
2001	11.4	11.0	8.6	7.8
2002	11.4	11.0	8.6	7.7
2003	11.4	10.7	8.6	7.6
2004	11.4	10.7	8.6	7.5
2005	11.4	10.3	8.6	7.5

FIGURE 6-8: Vehicle Fuel Efficiency – EnerGuide Labelling

	Percentage of New Vehicles with EnerGuide Label Affixed	
	New vehicles on lot with EnerGuide label	New vehicles in showroom with EnerGuide label
1999	64	47
2001	77	56
2005	78	61

FIGURE 6-9: Vehicle Fuel Efficiency Awareness – Program Activities

	Recollection of information on how to reduce vehicle fuel consumption (general public)	Awareness of program activities (general public)
1998	30	9
2002	36	16

FIGURE 6-10: Number of Idling Reduction Devices Purchased and Claimed Under Commercial Transportation Energy Efficiency Rebate (CTEER) Initiative

	2004–2005	2005–2006
Auxiliary Power Units (APUs)	1342	5376
Heaters	9323	1202

FIGURE 6-11: Participation in the Fleet Vehicles Initiative, 1998 to 2005

	Members
1998	946
1999	1068
2000	1643
2001	2707
2002	2805
2003	3267
2004	3625
2005	4733

FIGURE 6-12: Drivers Trained, 1998 to 2004

	Number of new drivers
1998	51 000
1999	53 000
2000	112 846
2001	125 000
2002	149 000
2003	160 000
2004	200 000

15048

FIGURE 7-1: Canadian Wind Power Capacity, 1990 to 2005

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Wind power capacity (MW)	0	0	0	19	19	20	20	21	24	124	137	214	230	327	444	683

FIGURE 8-1: GHG Emissions Reductions From Federal Operations, 1990 to 2010

Fiscal year	Emissions (kt of CO_2e)
1990	3895
1998	3140
2000	3012
2001	2895
2002	2957
2003	2829
Target 2010	2703

FIGURE 8-2: Annual Energy Savings From Energy Technology Applications Group, 1991 to 2005

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Annual (cumulative)	20	70	110	180	270	350	427	504	597	700	812	929	1039	1149	1263

FIGURE 8-3: Federal Fleet Size and Fuel Consumption, 1995 to 2004

	1995	1997	1998	1999	2000	2001	2002	2003	2004
Vehicles	24 944	22 873	22 505	22 558	22 611	24 463	26 233	24 981	25 666
Litres of gasoline equivalent (thousands)	76 800	64 200	63 100	63 100	61 900	66 900	68 619	62 500	65 000

FIGURE 8-4: Purchases of Alternative Fuel Vehicles (Including Hybrids) for the Federal Fleet, 1997 to 2004

Fiscal year	1997	1998	1999	2000	2001	2002	2003	2004
Vehicles purchased	131	161	181	83	170	521	365	529

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